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A REVIEW OF THE GENERA AND NESTING HABITS OF SWIFTS

BY DAVID LACK

This paper was begun as a comparison of the nesting habits of different kinds of swifts (Apodi), the literature on which is very scattered. But as the work progressed, I became dissatisfied with the existing generic classification, as in the last full list by Peters (1940), so I have here revised the genera, in which, incidentally, nesting habits provide a valuable guide, as pointed out by Sick (1947, 1948a, b, 1951). I have not tried to revise the species, though I have made a few suggestions; the species of *Apus* are being reviewed elsewhere (Lack, *in press*).

This paper is based primarily on the published literature, but I have also examined the large collection of swifts in the British Museum (Natural History) and am grateful to Mr. J. D. Macdonald for his friendly help in doing so. I am also most grateful to Dr. A. J. Cain, Dr. E. Mayr, and Mr. R. E. Moreau for their valuable criticisms of the paper in preparation.

Families and subfamilies.—In Peters' list, the Apodi are divided into two families, the Hemiprocnidae and Apodidae, and the latter are subdivided into the Apodinae and Chaeturinae. The Hemiprocnidae differ from the Apodidae in the much less modified humerus and the less modified feet, which make it possible for them to perch freely on trees. They agree with *Cypseloides*, but differ from all other Apodidae, in having a diastataxic, not eutaxic, wing, another primitive feature (Stresemann, 1927–1934). They have specialized plumage and nesting habits. The Chaeturinae are separated from the Apodinae by having unspecialized feet, whereas in the Apodinae the hallux is pointed more or less forward (instead of opposed to the other three toes), and the number of phalanges on the third and fourth toes is reduced to three on each (from four and five respectively).

The above subdivision of the family has long been accepted and seems justified on all grounds, including nesting habits. It may be

added here that all swifts use saliva for sticking together the materials of their nests, and all, so far as known, have enlarged salivary glands in both sexes in the breeding season. This diagnostic character separates them from the hummingbirds (Trochili), with which they are usually united in one order (for discussion of which see, for instance, Clark, 1906 and Lowe, 1939, who lists previous references). It is probably time that this last question was reopened.

The nature of the genus.—The genus is a unit for arranging species in convenient groups, a purpose which is defeated if there are many monotypic genera. It is widely agreed, for instance, that the splitting of *Chaetura* by Mathews (1918) or of *Apus* by Roberts (1940) was not merely unnecessary but undesirable. The genus also denotes affinity and a certain degree of differentiation. Traditionally, morphological characters have been used for the separation of genera and they are usually of value, because closely related species are often more similar in their morphological characters than in color or size. In swifts, however, some of the morphological characters on which reliance has been placed seem highly modifiable, particularly the furcation of the tail and the position and feathering of the toes. When, on the basis of all characters treated together, two species seem closely related, I have put them in the same genus, even if they differ in one of these morphological characters. This brings related species together, but in some cases it makes a genus hard to define.

Hemiprocnidae.—There is only one genus with three species, *Hemiprocne comata*, *longipennis*, and *mystacea*, which are clearly separated by size and color. *H. mystacea*, with a wing-length of over 230 mm., is one of the largest of all swifts. The birds are confined to southeastern Asia and associated islands, one species extending as far as the Solomon Islands.

The nests of all three species have been described (Meyer, 1928; Van Meurs, 1928; Bartels, 1929; Baker, 1934; Lowther, 1949; Gibson-Hill, 1950). The nest is placed on a light branch, commonly 25 to 40 feet above the ground, occasionally much higher, and consists of a cup some one and a half inches across, made of fragments of bark and small feathers. It is literally an egg-cup, since it is just large enough to hold the single egg. The weight of the brooding bird is supported by the branch, and the bird may incubate horizontally or vertically or intermediately (on this point see particularly Lowther, 1949). The egg is glued to the nest with saliva, an adaptation otherwise found only in *Cypsiurus parvus*. In both these birds, the egg presumably has some adaptation not found in other birds to obviate

the need for turning during incubation. The nestling is hatched naked, like other swifts, but unlike all others except *Cypsiurus parvus*, it later develops down, which is protectively colored.

The resemblances in nesting biology between *Hemiprocne* and *Cypsiurus* may reasonably be ascribed to convergence. These are the only two genera which have exposed nests (hence the advantage of nestling down) and the only two which have a shallow nest which is liable to sway (hence the advantage of the eggs being fixed).

Genera of Chaeturinae.—It is in the genera of Chaeturinae that my arrangement differs most from that of Peters (1940), but it is scarcely new, since with one exception I have returned to that of Hartert (1892).

Peters used nine genera, namely *Collocalia, Hirund-apus, Streptoprocne, Aërornis, Chaetura, Zoonavena, Mearnsia, Cypseloides,* and *Nephoecetes*. Hartert used only three, *Collocalia* (with normal tail feathers), *Chaetura* (with very stiffened rectrices and spiny tips) and *Cypseloides* (with somewhat stiffened rectrices and no spiny tips). *Collocalia* has remained unchanged, and need not be discussed further here. Hartert's *Chaetura* included the species placed there by Peters except for *C. rutila* (which Hartert placed in *Cypseloides*), and it also included the species grouped by Peters in *Hirund-apus, Streptoprocne, Aërornis* (part), *Zoonavena*, and *Mearnsia*. Hartert's *Cypseloides* included the species placed by Peters in *Cypseloides, Aërornis* (part), and *Nephoecetes*, also *C. rutilus* placed by Peters in *Chaetura*.

Most workers in the last fifteen years have brought back *Hirund-apus, Zoonavena*, and *Mearnsia* into *Chaetura*, thus uniting all the species with prominent spiny tips to their tails into the same genus. This leaves *Chaetura* as it was used by Hartert, except for the exclusion of the three species later placed in *Streptoprocne* (*zonaris, biscutata*, and *semicollaris*). No one has disputed that *Hirund-apus, Zoonavena, Mearnsia*, and *Chaetura* (in the narrow sense used by Peters) together form a natural group, the members of which are more closely related to each other than to any other swifts. Hence the further discussions of these birds may be considered later under *Chaetura*.

Cypseloides is more difficult. Zimmer (1945, 1953) has restored Hartert's arrangement, bringing back into this genus the species which in Peters' list are referred to as *Aërornis senex, Chaetura rutila*, and *Nephoecetes niger*. By implication, Zimmer retained *Streptoprocne* with its customary three species. On this arrangement, some workers have found it hard to place the species *semicollaris*, the existence of

which was Peters' main reason for using *Aërornis*. Together with *senex*, the other species placed by Peters in *Aërornis*, it seems to bridge the gap between *Streptoprocne* and *Cypseloides*. In color pattern and size *semicollaris* is much more like the two other species normally placed in *Streptoprocne* than any other swifts, but it has a square, not forked, tail. The best solution, I suggest, is to transfer the three species of *Streptoprocne* to *Cypseloides*, uniting them with all the species that Hartert and Zimmer placed in that genus.

Summing up, I have returned to the generic arrangement of Hartert except for the transfer of *zonaris*, *biscutata*, and *semicollaris* from *Chaetura* to *Cypseloides*. The three genera may still be defined in terms of the tail feathers, much as they were by Hartert: rectrices normal (*Collocalia*), rectrices stiffened with prominent spiny tips (*Chaetura*), rectrices somewhat stiffened with slightly projecting bare tips, except in one species (*Cypseloides*).

The last group requires further explanation. The exceptional species is *C. niger*, which has normal tail feathers without spiny tips, but in its dark plumage and in nesting habits it agrees so closely with the other species of *Cypseloides* that obviously it is closely related and so should be put with them. All the other species of *Cypseloides* that I have examined (*zonaris*, *biscutatus*, *semicollaris*, *senex*, *rutilus*, and *fumigatus*) have slightly projecting bare tips to the stiffened rectrices (the rectrices seeming to be disproportionately stiffer in the larger than the smaller species). It was because they had bare tips to the rectrices that Hartert kept *zonaris*, *biscutatus*, and *semicollaris* in *Chaetura* and that Peters later transferred *rutilus* to *Chaetura*. But *senex* and *fumigatus* also show this character. Now in all six of these species, the bare tips are much less definite than in any species of *Chaetura* (as used here). Their appearance is as if the barbs had worn away through abrasion, whereas in *Chaetura* (as used here) the spines are prolonged and obviously specialized. Hence *Cypseloides* can still be separated from *Chaetura* by the nature of the bare tips, but this is a less clear-cut character than formerly stated.

A further difficulty for some workers has been that among the species here grouped in *Cypseloides*, the tail is in some species well forked, in others straight or slightly rounded, and in delimiting genera great weight has often been given to this character. In the three species of the *Streptoprocne* group, for instance, the tail is well forked in *zonaris*, slightly forked in *biscutatus*, and not at all forked in *semicollaris*. Seeing that *biscutatus* is intermediate, there seems no good reason for putting *semicollaris* in a separate genus simply

on the grounds of this one feature. Of the other species, the tail is forked in *C. niger* and *C. rutilus*, but not in *C. senex*, *C. fumigatus*, *C. cherriei*, or *C. cryptus*. The furcation of the tail is evidently a modifiable character which should not be used for generic separation in the *Cypseloides* group.

Fortunately, there are three other characters in which *Cypseloides* (as used here) can be satisfactorily separated from *Chaetura*. First, the wing is described as diastataxic, a primitive feature, and not eutaxic as in all other swifts except the Hemiprocnidae (Clark, 1906; Stresemann, 1927–34). Secondly, as pointed out by Ridgway (1911), in *Cypseloides* (including *Streptoprocne* and *Nephoecetes*) the hallux is longer, more than half as long as the inner toe, whereas in *Chaetura* the hallux is shorter, less than half as long as the inner toe. When a swift clings to a vertical surface, it grips with both feet and tail, and it seems clear that in *Chaetura* the reduction in the length and strength of the hallux has been evolved at the same time as an increase in the length and strength of spiny tips to the rectrices. Thirdly, the nesting habits and clutch-size of *Cypseloides* and *Chaetura* are very different, as discussed later.

Species of Cypseloides *(Black or Primitive Swifts)*.—The critical morphological characters of the species in this group have been discussed in the previous section. As mentioned, eight species here grouped in *Cypseloides* come from five different genera in Peters' arrangement, but if the tail is regarded as a modifiable character, all can be grouped together, with a ninth species *C. cryptus* described by Zimmer (1945) since Peters' list was published.

All nine species have uniformly black upper and under parts. Indeed, they are normally blacker than the species of *Apus*. Zimmer (1945) has pointed out that they differ from all the species of *Chaetura* in America (with which alone they come in contact) in having the rump as dark as the back, whereas in the American species of *Chaetura* the rump is always paler than the back (being slightly paler even in *C. pelagica*). The only interruption of black in their plumage occurs in the region of the head. Thus *C. zonaris* has a complete ring of white round the neck, *C. biscutatus* is white on the hindneck and chest (i.e. the ring is interrupted on the sides of the neck), and *C. semicollaris* is white on the hindneck only. This is another character in which *C. biscutatus* is intermediate between the other two. *C. rutilus* has a rufous collar which in shape is very like the white collar of *C. zonaris*. *C. cherriei* has a white spot on each side of the forehead, *C. cryptus* pale marks on the sides of the forehead and often a white chin, *C.*

fumigatus at times a pale chin, *C. senex* a grayish head, but *C. niger* has no white area. (For the descriptions of *C. cryptus* and *C. cherriei* in this account, I have relied on Zimmer, *loc. cit.*)

Otherwise, the species differ mainly in size; the smallest being *C. rutilus* and *C. cherriei* (with wing-lengths around 120–130 mm.) and the largest, the three species formerly placed in *Streptoprocne* (with wing-lengths over 200 mm.). *C. semicollaris*, with a wing-length of over 230 mm., is one of the largest of all swifts.

The group is confined to tropical America except for *C. niger*, which ranges north to southeastern Alaska.

Nests of Cypseloides *species*.—The nests of four species, *C. cryptus*, *C. cherriei*, *C. biscutatus*, and *C. semicollaris*, have not been recorded. Those of the other species are closely similar in site, structure, materials, and clutch-size. *C. niger* nests on inland cliffs behind or close to waterfalls, or over a pool, also on steep sea cliffs. The nest is cone-shaped on the outer side, made of mud and moss, and lined with fern tips. The clutch is invariably 1 (Bent, 1940; *cf.* Michael, 1927; Smith, 1928; Knorr and Baily, 1950). *C. rutilus* has been found nesting in a gorge over a stream, also in dark culverts two feet above the water, the nest is again a half-cone, made of mud and moss, and lined with ferns; the clutch (three records) being two (Belcher and Smooker, 1936; also Orton, 1871). *C. senex* nests behind a rock over which water falls (v. Ihering, 1900). *C. zonaris* nests behind waterfalls (Beebe, 1949, citing Todd and Carriker, 1922; also Naumburg, 1930; Sutton, 1951), also on the steep sides of barrancas (Reboratti, 1918) or in holes in rocks or caves (Salmon, cited by Sclater and Salvin, 1879), while an old record strongly suggests that in Jamaica it may also nest on sea cliffs like *C. niger*. (Gosse, 1847, also Taylor, 1955). The cone-shaped nest is made of mud and moss lined with small twigs or fragments of fern (Reboratti, 1918). Mud and moss were also mentioned by Salmon and twigs by Todd and Carriker. The clutch is one or two (Salmon, Reboratti, Todd and Carriker; Reboratti said that one is usual). *C. fumigatus* also nests in steep barrancas, the nest being of the same shape as in the other species and made of mud and moss and lined with fern, the clutch 1 (Reboratti, 1918). (A nest said to have been of this last species was described by Holt, 1927–28, in Brazil, but as it was attached to the brickwork on the inside of a house gable, was made of glued twigs and contained five young, this obviously refers to the nest of some *Chaetura* species.)

Hence all the species of *Cypseloides* for which the nest is reliably known agree in building on steep cliffs, usually in association with water, making a cone-shaped nest of mud and moss lined with fern-

tips or twigs, and in laying a clutch of only one or two eggs. In all these characters, they are clearly separated from the species of *Chaetura*. They are also separated from them by their roosting habits. The species of *Chaetura*, so far as known, roost (as they nest) in hollow trees or chimneys, sometimes in great numbers. *Cypseloides zonaris* also roosts as it nests, large numbers flying behind waterfalls (Salvin and Godman, 1888–1904; Davis, 1945; Ribeiro, cited by Sick, 1947). Again, *C. rutilus* roosts clinging to rocks (Beebe, 1949). Incidentally, Beebe's photograph of *C. rutilus* clinging to a vertical surface shows the use of the tail for gripping and the small bare tips to the rectrices. It may be compared with a photograph of *Apus apus*, which also uses the tail for gripping when roosting on a vertical wall, though it has not developed bare tips to the rectrices (J. Markham, in Nicholson, 1951).

Two queries about the breeding of *Cypseloides* may be added. First, how do these birds collect the mud and moss for their nests? All other swifts, so far as known, collect nesting material (other than saliva) in flight. Do the species of *Cypseloides* alight to collect mud, or could they obtain it in flight by skimming over shallows in the way that various swifts skim over water to drink or bathe? The latter seems unlikely, and an observation by Michael (1926) shows that they alight on rocks near waterfalls. Secondly, where, as in *C. zonaris*, the birds actually fly through a waterfall to nest, the first flight of the young swift, through the curtain of water to independence, must be quite something.

Nesting of Collocalia *species*.—The species of *Collocalia* comprise a comparatively uniform group of dull gray-brown, sometimes glossy, birds with square or slightly forked tails; most of them have a wing-length of 110 to 140 mm. Some species are easy to recognise from skins, but others, notably those usually placed in or close to *C. francica*, *C. fuciphaga*, and *C. vestita* in their wide sense, present a bewildering degree of variation, and the specific and racial determinations are confused (*cf.* Mayr, 1937). A specific list has not been attempted here. For clarity, I have in some of the cases which follow used alternative specific names where both have been in frequent use (the subspecific name is often the best guide to the bird intended).

All the species, so far as known, build their nests on the walls of caves, which may be on the sea coast or inland, including high in the mountains. Many species nest in huge colonies, but the White-breasted Swiftlet, *C. esculenta*, usually nests in small groups and, though it nests in caves where present, it also nests in more open rocky sites, occasionally beside a waterfall (E. Sutter, *in litt.*) and

also in large hollow trees (Mayr, 1945). This species also uses the buildings of man in various parts of its wide range (Franck, 1926; Spennemann, 1928a; Baker, 1934; Mayr, 1945). The Gray-rumped Swiftlet, *C. inexpectata* (or *francica*) *amechana*, likewise uses buildings in Singapore (Gibson-Hill, 1948), and so does the same species (presumed; it was called *C. francica vestita*) in Java (Franck, 1926; Spennemann, 1928b).

All the species, so far as known, build a small bracket-shaped nest on a vertical wall, in this respect resembling *Chaetura*, but the material is different. The white nests of commerce, made of pure saliva, come primarily from the Gray-rumped Swiftlet, *C. inexpectata* [or *francica*], (Baker, 1934; Banks, 1949; Gibson-Hill, 1948), also from the Brown-rumped Swiftlet, *C. vestita*, (Banks, 1949; Gibson-Hill, 1948), while the Pygmy Swiftlet, *C. troglodytes*, is also said to have an edible nest (McGregor, 1909; Manuel, 1937; Delacour and Mayr, 1946). The other species include much other matter: chiefly moss and lichen, sometimes other vegetable matter in *C. esculenta* (Spennemann, Baker, Banks, Gibson-Hill, *op. cit.*); moss and other vegetable material in the Australian Pale-rumped Swiftlet, *C. spodiopygia* (*francica*) *terrae-reginae*, (Mathews, 1918); moss in *C. whiteheadi* (Delacour and Mayr, 1946); feathers in Robinson's Swiftlet, *C. lowi robinsoni*, (Banks, Gibson-Hill, *op. cit.*) and the related *C. lowi tichelmani* (Stresemann, 1926); vegetable matter in *C. f. fuciphaga* from Java (Stresemann, 1926); grass and feathers in Hume's Swiftlet, *C.* (*fuciphaga*) *innominata*, also in the Plain-rumped Swiftlet, *C.* (*brevirostris*) *unicolor*, and the Himalayan Plain-rumped Swiftlet, *C.* (*fuciphaga*) *brevirostris*, (Baker, 1934), the last species also using moss (Glennie, 1944). In the Solomon Islands, Dr. A. J. Cain (*in litt.*) twice saw *C. esculenta* hovering or turning upside down in the air to snatch at hanging shreds of bark and moss. There are no observations suggesting that the species of *Collocalia* alight to collect nesting material.

The full clutch of most species is two, this applying to the forms *innominata*, *unicolor*, and *brevirostris* just mentioned (Baker, 1934), and to *C. esculenta*, *C. vestita*, and *C. inexpectata* (Stresemann, Baker, Banks, Gibson-Hill, *op. cit.*). But Spennemann (1928a) found some nests of *C. esculenta* with only one well-incubated egg (*cf.* Mayr, 1945). A single egg is normal in *C. lowi robinsoni* (Banks, Gibson-Hill, *op. cit.*) and in *C. lowi tichelmani*, which builds a small nest in proportion to the size of the bird (Stresemann, 1926). Many nests with one egg were also found in the Australian *C. spodiopygia terrae-reginae*, but the original record suggests that laying had only just started

at this colony, so this may not have been the full clutch (Mathews, 1918).

Species of Chaetura (*Spine-tailed Swifts*).—As already mentioned, I agree with most other workers since Peters in merging *Hirund-apus* (2 or 3 species), *Zoonavena* (1 species) and *Mearnsia* (4 species) with *Chaetura*.

Mearnsia has been separated primarily on account of the extremely short tail. But when color pattern is taken into consideration, two species, *C.* (*Mearnsia*) *picina* from the Philippines and *C.* (*M.*) *novaeguineae* from New Guinea, are very like each other but very different from the two other species, *C.* (*M.*) *cassini* and *C.* (*M.*) *böhmi*, both African. In color, the two latter closely resemble each other and also two other African species usually placed in *Chaetura* in the restricted sense (see later), and I therefore suggest that these four African species are related. Finally one of the American species, *C. brachyura*, also has a short tail and so might qualify for a place in *Mearnsia*, but in color pattern it is closest to the other American forms. I therefore suggest that in the spine-tailed swifts a short tail has been evolved separately at least three times, and that it should not be used for generic separation.

If the *Chaetura* group is to be subdivided, I suggest that color provides a truer guide to affinities than the morphological characters usually employed. Supporting this view, a grouping on the basis of color brings the birds of each main region into the same group. The natural subdivisions of the genus are in my view (i) all the American species, (ii) all the African species, that from Madagascar and adding the two white-rumped Asiatic species, (iii) the large species from southeastern Asia sometimes placed in *Hirund-apus*, (iv) the large but short-tailed birds from New Guinea and the Philippines sometimes placed in *Mearnsia* (but the other forms placed in *Mearnsia* belong to group ii).

(i) The American species form a closely knit group of similar size, with dark upper and underparts, and with the rump varying from buff-gray to almost, if not quite, as dark as the back. Peters listed eleven species, *chapmani*, *pelagica*, *vauxi*, *richmondi*, *gaumeri*, *nubicola*, *cinereiventris*, *spinicauda*, *martinica*, *andrei*, and *brachyura*. Of these, *nubicola* is a synonym of *Cypseloides rutilus* (Friedmann *et al.*, 1950), and recent workers have treated *richmondi* and *gaumeri* as subspecies of *vauxi*.

This leaves eight species, but I wonder if further reduction is not desirable. *C. vauxi* and *C. pelagica* are allopatric, and though they

do not intergrade, the differences between them, in the shade of the underparts and in size, are of the same order as those separating some of the subspecies in species of *Apus* (*cf.* Lack, *in press.*) *C. chapmani* also appears to belong to the same group as *vauxi* and is again allopatric. Where there is doubt concerning closely related allopatric forms, it is in general better to classify them as subspecies, not species (Mayr *et al.*, 1953), and this has the advantage of indicating their affinity. Is there not sufficient doubt in the case of *chapmani, vauxi,* and *pelagica*? Likewise *C. martinica* is allopatric with *C. cinereicauda*, to which it is closely related (Bond, 1936); might it not be regarded as a well-marked insular subspecies? If these suggestions are acceptable, there are only 5 American species of *Chaetura*. Because they are not yet accepted, I have for convenience classified the nesting records for *C. pelagica* and *C. vauxi* separately in the next section.

(ii) Of the African species listed by Peters, *thomensis* is a well-marked race of *C. sabini*. Four of the five good species, *C. sabini, C. ussheri, C. cassini,* and *C. böhmi*, agree in a characteristic color pattern of dark and slightly glossy upper parts and dark chests, but white rumps and abdomens. The remaining African species, *C. melanopygia*, has a dark rump and abdomen but strongly resembles *C. ussheri* in its scaly chest and seems to belong to the same group. Also two Asiatic species, *C. sylvatica* and *C. leucopygialis*, have somewhat glossy upper parts and mainly white rumps, while *C. sylvatica* also has a pale abdomen like the African species and *C. leucopygialis* has a mainly white tail like *C. sabini*. I think that all these birds are closely related. The Madagascar species, *C. grandidieri*, with dark brown upper parts, a paler rump, and gray-brown underparts, is so similar to *C. sabini*, except in color, that I regard it as closely related.

(iii) The species sometimes grouped in *Hirund-apus*, *C. caudacuta* and *C. gigantea* (with *C. cochinchinensis* as a possible third species—Biswas, 1951), are clearly separated from the subgroups already mentioned by their great size, glossy blue-black wings and rump, brown back and underparts.

(iv) *C. picina* and *C. novaeguineae* resemble the species of group (iii) in plumage more closely than they do any other swifts, since they likewise have glossy blue-black upper parts, including the rump, while *C. picina* also has a prominent white throat like *C. caudacuta* and is of large size. But they differ from the *Hirund-apus* section in various ways, including the short tail, and seem best retained provisionally as a fourth group.

The difference between, say, *C. gigantea* and *C. böhmi* is so great

that a case can be made for using further genera. If this is done, I think that the group is best divided into four genera as indicated in groups (i) to (iv). But I see no real need for this, and it is better not to introduce more names than are really needed. Different though some of the species are, I think there is no doubt that they are more closely related to each other than to any other swifts, and this is borne out by the similarity in their nesting, mentioned later.

It is interesting that of the nine genera into which the swifts have been grouped in this paper, *Chaetura* is the only one with representatives in both the Old and New worlds. Even in *Chaetura*, the New World species resemble each other more closely than they do any of the Old World species.

Nesting of Chaetura *species.*—All the species of *Chaetura* nest in the same way, as stressed by Sick (1948, 1951), with the partial exception of the *Hirund-apus* subsection (considered in a later paragraph). The nest is in a hollow tree, which the bird normally enters by diving in from above, though it sometimes ascends from below if there is a gap near the roots. The nest is bracket-shaped and attached to a vertical surface, and is made of fine twigs. In *C. pelagica*, and presumably other species, the twigs are broken off by the feet as the bird flies past. This description applies, so far as their habits are yet known, to the North American *C. pelagica* and *vauxi* (Bent, 1940); to the tropical American *C. p.* (or *v.*) *richmondi* (Dickinson, 1951), *C. andrei* (Sick, 1948, 1951), *C. cinereiventris* (Sick, 1948, citing Ribeiro, 1929) and *C. brachyura* (except that the nest was in a cave not a tree; Belcher and Smooker, 1936); also to the Indian *C. sylvatica* (Baker, 1934) and to the African *C. sabini* (Bates, 1911), *C. ussheri* and *C. cassini* (Bannerman, 1933; Chapin, 1939), and *C. böhmi* (except that the nests of the last species were in bore-holes or caves, not trees; Vincent, 1946; confirmed by numerous records *in litt.* from E. L. Haydock in Northern Rhodesia; the nests were up to 25–30 feet below ground level and were made of bark, feathers, and sometimes twigs). This extreme similarity in nesting habits strongly supports the view that all the species here placed in *Chaetura* are closely related and should be united in one genus. As yet, the nests of *C.* (*pelagica*) *chapmani*, *C. spinicauda*, and *C.* (*cinereiventris*) *martinica* in group (i), of *C. melanopygia* and *C. grandidieri* in group (ii), and of *C. picina* and *C. novaeguineae* which together comprise group (iv) have not been described.

Various of the above species, like many other swifts, have found an artificial equivalent to their natural site. The North American

C. pelagica now breeds much more often in chimneys than in trees, and chimney-nesting has also been recorded in *C.* (*p.*) *vauxi* in western North America (Bent, 1940), in *C. p.* (or *v.*) *richmondi* in Venezuela (Sutton, 1948), *C. andrei* in Brazil (Sick, 1951), *C. brachyura* in Trinidad (Belcher and Smooker, 1936) and *C. ussheri* in Africa (Bannerman, 1933; Chapman, 1939), while, as noted above, *C. böhmi* has been found nesting in mine-borings. Only *C. böhmi* and *C. brachyura* (Belcher and Smooker, 1936) have been recorded nesting in caves.

The large species in the *Hirund-apus* subsection form a partial, but only partial, exception. *C. caudacuta* regularly nests in large hollow trees (Jahn, 1942; Austin and Kuroda, 1953) and so does *C. gigantea* (Baker, 1934), and both enter in the typical chaeturine way by diving in from above. *C.* (*caudacuta*) *cochinchinensis* has been found breeding in man-made caves in forested country (Baker, 1934). It is stated in various general works that the members of this group also breed in rocky cliffs in high mountains, but I cannot find any definite published records to substantiate this. *C.* (*c.*) *caudacuta* and *C.* (*caudacuta*) *cochinchinensis* build bracket-shaped nests attached to a vertical surface. The nests, however, are made not of twigs but of dried moss and hair; they may be six inches across (Baker, 1934). *C. gigantea*, unlike other *Chaetura* species, makes a simple hollow in the dirt at the bottom of a hollow tree, where the eggs get very stained (Baker, 1934). The large size of this species might make it difficult to construct a sufficiently strong bracket-nest.

Clutch-size in *Chaetura* is greater than in the other genera of swifts except *Aëronautes*, four to five, occasionally three or six, in *C. pelagica* and four to six, occasionally three, in *vauxi* (Bent, 1940); five in *C. cinereiventris* (Sick, 1948, citing Ribeiro, 1929), three in *C. brachyura* (Belcher and Smooker, 1936), four in *C. ussheri* (Chapin, 1939), three in *C. böhmi* (Vincent, 1946), two or three in *C. sabini* (Bates, 1911), three to five in *C. sylvatica* (Baker, 1934), three or four, occasionally two or five, in *C. gigantea* (Baker, 1934), two or three in *C. caudacuta* (Austin and Kuroda, 1953).

Genera of Apodinae.—Peters (1940) used seven genera, four of which were monotypic while two included only two species in each. This arrangement derives from Hartert (1892), who divided the Apodinae into two main groups on the basis of the toes; they are:—

(i) all directed forward:	*Apus, Aëronautes, Panyptila*
(ii) in opposed pairs:	*Tachornis, Cypsiurus, Reinarda*, to which should be added the later-discovered *Micropanyptila* (Sutton, 1928).

Hartert further subdivided each of these two groups into two, according to whether the toes are bare or feathered. In group (i) they are bare in *Apus* but feathered in *Aëronautes* and *Panyptila;* in group (ii) they are bare in *Tachornis, Cypsiurus,* and *Micropanyptila* but feathered in *Reinarda.*

This division of the group does not, in my view, show the true affinities of the various forms. Instead, I suggest that both the position and the feathering of the toes are highly modifiable characters which should not be used in classifying the Apodinae. In this connection two points may be particularly noted. First, the newly hatched *Apus apus* has the toes in opposed pairs, not all forward (Ingram, 1955), and thus resembles *Tachornis, Cypsiurus,* and *Reinarda* and differs from the adults of its own species. Secondly, the species *andecolus* has bare toes and so has hitherto been placed in the genus *Apus,* but its general appearance, including the distribution of white areas on the plumage, also its geographical range, show that it is related to the two species of *Aëronautes* (also to *Panyptila,* but not to *Apus*), and it is here placed in *Aëronautes.*

For reasons given in detail later, I propose to treat *Tachornis phoenicobia, Reinarda squamata,* and *Micropanyptila furcata* as congeneric, since they show resemblances to each other in color pattern, nesting habits, and geographical range and seem more similar to each other than to any other swifts. *Tachornis* is the oldest available generic name. In the following discussion *Tachornis* covers these three species, not merely *T. phoenicobia.* But, as explained later, *Cypsiurus parvus,* which has sometimes been placed in *Tachornis* in the past, is here retained as a monotypic genus.

I therefore divide the Apodinae into five genera, *Apus* with ten species, all from the Old World, *Cypsiurus* with one species from the Old World, *Aëronautes* (including *andecolus*) with three species from the New World, *Panyptila* with two species from the New World, and *Tachornis* (*sens. lat.*) with three species from the New World.

Apus and *Cypsiurus* resemble each other and differ from the three American genera in having dark underparts (save for the pale chin). The only exception is *Apus melba,* which has mainly white underparts, but this condition can easily be derived from *Apus aequatorialis,* in which the corresponding feathers are barred with white. Each of the American species, on the other hand, has a large area of white on the underparts. Further, as compared with *Aëronautes, Panyptila* has a white nape like *A. andecolus,* white sides to the rump like *A. andecolus* and *A. saxatilis,* a white throat and upper chest like *A. saxatilis,* and white bases to the secondaries, like *A. saxatilis.* These resemblances are far too striking to be due to chance, and surely indi-

cate that *Panyptila* and *Aëronautes* (including *andecolus*) are closely related.

At the same time, *Panyptila* shows strong resemblances to *Tachornis* (*sens. lat.*) in nesting habits, since these are the only swifts which suspend a nest from the underside of a tree, the nest being entered from below by a long tube. In both genera, the nesting chamber is a globular sac of plant fibres and feathers, and in *Panyptila* and one species of *Tachornis* the material is worked into a close felt. The main difference between them is that the tubular entrance is formed by hanging leaves or a spathe in *Tachornis* but is made by the bird in *Panyptila*. No other swifts build in anything like this way, which strongly suggests that *Panyptila* and *Tachornis* are closely related. *Cypsiurus parvus*, on the other hand, which has hitherto been thought to be related to *Tachornis phoenicobia*, differs strikingly in nesting habits, building a shallow, spoon-shaped strip to which the eggs are stuck with saliva.

In view of this evidence, I suggest that the main division of the Apodinae is between the Old World forms (*Apus* and *Cypsiurus*) on the one hand, and the New World forms (*Aëronautes*, *Panyptila*, and *Tachornis*) on the other. On this view, either the condition with all the toes forward, or that with the toes in opposed pairs, has been evolved more than once. The latter seems the more specialized condition, and it is in fact confined (in the adult) to the palm-nesting species—*Tachornis* in the New World and *Cypsiurus* in the Old. But it is also found in the nestling *Apus*, which suggests that the same conditions in Palm Swifts may be neotenic.

The furcation of the tail is another morphological character which appears to be highly modifiable in the group. Thus the tail is strongly forked in *Cypsiurus*, *Panyptila*, and two species of *Tachornis*. In all save one of the other species of Apodinae the tail is moderately forked, though to a variable extent, while in some forms of *Apus affinis* it is almost square. For this reason, *affinis* has sometimes been placed in a monotypic genus, but it is closely similar in color pattern and nesting habits to *Apus caffer*, to which it is presumably related.

I do not propose to subdivide *Apus*, or any other genus of the Apodinae. The remaining question is whether as many as five genera are needed for the group. I think that they are. With the transfer of *andecolus* from *Apus* to *Aëronautes*, these two genera can no longer be differentiated, as hitherto, by the presence or absence of feathering on the toes. Indeed, they are extremely difficult to define except in terms of their range, in the Old and New worlds, respectively. On the other hand, I consider that they are less closely related to

each other than is each to the other genera in the Old and New worlds, respectively. Hence they must be kept separate. Of the Old World genera, the monotypic *Cypsiurus* is very different from any species of *Apus*, so should be kept separate. Of the New World genera, *Panyptila* might be united with *Aëronautes* on the basis of plumage but is strikingly different in nesting habits; while it might be united with *Tachornis* on the basis of nesting habits, but differs greatly in color. Hence I think it best to retain all five genera.

The species of Apus.—A revision of the species of *Apus* is being published elsewhere (Lack, *in press*). The task has proved extremely difficult, owing first to the similarity of some of the species and secondly to the marked differences in pigmentation and size in some subspecies of the same species. As a result, there are several instances in which a subspecies looks less like another race of its own species than like another species. Such convergent resemblances at the specific level are hard to detect.

The following changes, some of them tentative, are proposed from Peters (1940): (i) the transfer of *andecolus* from *Apus* to *Aëronautes*, already discussed, (ii) the elevation of *barbatus* from a race of *A. apus* to a full species, with *mayottensis* and *balstoni* (from *A. apus*), *sladeniae* (from a full species) and *bradfieldi* (from *A. aequatorialis*) as races of it, (iii) the abolition of the species *A. unicolor*, making *unicolor* and *alexandri* races of *A. apus* and *poensis* a race of *A. myoptilus*, (iv) the merging of *A. batesi* as another race of *A. myoptilus*, (v) the transference of the race *niansae* from *A. apus* to *A. pallidus*, (vi) the merging of *A. acuticaudus* as a race of *A. pacificus*, (vii) the merging of *A. toulsoni* as a race or variant of *A. horus*, and (viii) the merging of *A. reichenowi* as a variant of *A. aequatorialis*.

In all, this makes 10 species, *apus*, *barbatus*, *pallidus*, *aequatorialis*, *melba*, *myoptilus*, *caffer*, *horus*, *affinis*, and *pacificus*. There seems no case for further genera, as proposed by Roberts (1940), and it is hard to divide the species into subgroups with certainty. However, *A. aequatorialis* and *A. melba* seem very close to each other. So do *A. caffer*, *A. horus*, and *A. affinis*, as they are similar in color pattern, though *A. caffer* and *A. horus* have well-forked tails, and *A. affinis* a nearly square one.

Nesting habits of Apus *species*.—For completeness, I have in the following summary included notes on the nesting of those forms which I have relegated from full species to subspecies. The nests of all ten species as accepted here have been found (but the nests of *myoptilus* [*sens. strict.*], *toulsoni*, and *reichenowi* are unknown). Nine

of the ten species have been found nesting in rocks, though some of them also use other sites. The exception is *A. horus*, which (always so far as known) uses holes in banks, usually sandbanks, excavated by swallows, starlings, or possibly bee-eaters (Belcher, 1930; Friedmann, 1930; Roberts, 1940; Taylor, 1949; Clancey and Holliday, 1951; Dickin, 1952). Only one other species of *Apus* has been found nesting in sandy banks, there being one recorded of *A. apus* using the holes of Bank Swallows (*Riparia riparia*) in England (Oakes, 1953).

Of the nine rock-frequenting species, seven use holes or crevices, usually in inland cliffs, namely *A. apus* (Jourdain, 1901; Kelsall and Munn, 1905; Nelson and Clarke, 1907; Oakes, 1953), *A. barbatus* (Van Someren, 1922, who listed it as *A. roehli;* also Roberts, 1940; Benson, 1952), *A. pallidus*, *A. aequatorialis* (Masterson, 1945; Benson, 1952), *A. melba*, *A. caffer* (Roberts, 1939), and *A. pacificus* (Baker, 1934). Rock crevices are also used by various forms treated by previous workers as full species, including *A. apus unicolor* (Volsøe, 1951), *A. apus alexandri* (Bannerman, 1933; Bourne, 1955), *A. pallidus niansae* (Van Someren, 1922, who listed it as *nakuruensis*) and *A. pacificus acuticaudus* (Baker, 1934). On the other hand, *A. affinis* typically builds not in a crevice but under overhanging rocks or under the roof of a cave, and adjacent nests may actually touch each other (Baker, 1934; Roberts, 1939, 1940). *A. caffer*, though at times nesting in natural holes, has been found much more commonly using the old nests of martins and swallows, particularly those of species which build retort-shaped nests (Roberts, 1939, 1940; Vincent, 1946). The nests of hirundines on rocks are also used at times by *A. pacificus* and *A. affinis* (Baker, 1934), and this has been the site of the three recorded nests of *A. myoptilus batesi* (Bates, 1905; Serle, 1954). Holes in sea cliffs are used by *A. apus* in the British Isles (Stevenson, 1866; D'Urban and Mathew, 1895; Ussher and Warren, 1900; Forrest, 1907; Nelson and Clarke, 1907; Baxter and Rintoul, 1953), by *A. apus alexandri* in the Cape Verde Islands (Bourne, 1955) and by *A. pacificus* in China (Cochrane, 1920).

It is interesting that of the nine rock-frequenting species, as many as six also nest on or in buildings. These are *A. apus* in Europe and also *A. apus alexandri* in the Cape Verde Islands (Bourne, 1955); *A. melba* in Europe (Arn, 1945); *A. pallidus* in Europe (Hoffmann *et al.*, 1951) and Asia (Baker, 1927); *A. pacificus* in China but not Japan (Jahn, 1942); *A. caffer* in Africa (Lynes and Vincent, 1939; Roberts, 1939; Moreau, 1942a); and *A. affinis* in Asia (Baker, 1934) and Africa (Moreau, 1942b). The situation of the nest on or in a building varies with the species. Thus the nests of *A. apus* and *A. melba*

are normally invisible from outside, each pair of *A. apus* typically having a separate entrance-hole, whereas those of *A. melba* are commonly shared (personal observation). *A. pallidus*, on the other hand, often builds on the upper side of a rafter under the eaves in such a position that the sitting bird can be seen from outside (Hoffmann *et al.*, 1951, also personal observation), though many other nests have been recorded in holes, especially in Egypt and Asia. On a building, as on rocks, *A. caffer* often though not always selects the old nests of hirundines under the eaves (Lynes and Vincent, 1939; Roberts, 1939; Moreau, 1942a), *A. apus* occasionally nests in the same situation in England, using the nests of House Martins, *Delichon urbica*, (Price, 1888; and references there cited), and *A. pallidus* sometimes uses the open nests of Swallows, *Hirundo rustica*, (Hoffman, *et al.*, 1951). *A. affinis* typically builds its nest under the eaves of a house or on the underside of a roof, for instance of a mosque, recalling its natural site under overhanging rocks, and it also may use old martins' nests (Baker, 1934; Moreau, 1942b).

Only one species, namely *A. apus*, has been found nesting in trees, this being regular locally in Europe in old woodpecker holes. It nests in old pines in northern Scandinavia and Lapland (many references, and personal observation) and formerly in Scotland (Harvie-Brown and Buckley, 1895), also in Corsica (Jourdain, unpublished *MS* in Edward Grey Institute), and in old broad-leaved trees in parts of Germany and Bohemia (Dresser, 1871–81; Stadler, 1917; Niethammer, 1938) and probably formerly in England (D'Urban and Mathew, 1895). It also uses nesting boxes on trees in Germany (Niethammer, 1938) and in Switzerland (Weitnauer, 1947). In all these situations, the flight in to the nest is more or less horizontal, and the bird does not enter hollow trees by diving in from above, like *Chaetura*. Since *A. apus* has also been recorded nesting in rocks in both inland and sea cliffs, in buildings, the burrows of Bank Swallows, and the nests of House Martins, it has been recorded from more varied nesting sites than any other species of swift. This may be partly because it has been much more studied than any other species.

All save one of the species of *Apus* typically build a simple shallow cup placed on the floor of their crevice or hole (or old martin's nest). *A. affinis* differs from the rest in building a bag-shaped structure with a short tubular entrance attached to the underside of a rock (Baker, 1934; Moreau, 1942b). The only other partial exception is *A. melba*, which at times, but far from always, builds a bracket-shaped nest on a vertical wall, but often, like other species, it builds a simple cup on the floor (Boxberger, 1934, and personal observation).

All the species use as nesting material feathers, dried grass, and other vegetable matter, caught entirely in the air. This material is stuck together with saliva, often rather loosely. But *A. melba* welds bud scales and other small plant remains into a firm hard structure; although it is the largest species, it for the most part selects much smaller plant remains than do smaller species such as *A. apus*. Mud has been reported from the nests of several species, but it may be presumed that this was either a natural accumulation in a crevice or was brought there earlier by a martin.

Clutch-size is remarkably uniform in the genus, two or three eggs being the commonest clutch in every species. This holds for the following species (for which the references are those already given under nesting habits with a few additional sources listed here); *A. apus* (Lack, 1951a), *A. barbatus* (two records of 2, Van Someren, 1922, under the name *A. roehli;* Roberts, 1940), *A. pallidus* (Hoffmann *et al.*, 1951; F. C. R. Jourdain MS in Edward Grey Institute; also Van Someren, 1922, under the name *A. nakuruensis*), *A. melba* (Arn, 1945; Steyn, 1952), *A. myoptilus batesi* (two clutches and one brood of 2), *A. horus*, *A. caffer*, *A. affinis*, and *A. pacificus*. For several of these species there is good evidence of geographical variations in clutch-size, two being commonest in some parts of the range, three in others, as shown for *A. apus* (Lack, 1951a), *A. caffer* (Pitman, 1931; Lynes and Vincent, 1939; Moreau, 1942a; Vincent, 1946), *A. affinis* (Baker, 1934), and *A. pacificus* (Baker, 1934). In several of those populations in which three is the commonest clutch, a clutch of four is occasional, including *A. apus*, *A. melba*, *A. affinis*, and *A. pacificus*. A clutch of five seems unknown. Since various species of *Chaetura* commonly lay four to five eggs, this might suggest that the *Apus* model is less efficient than the *Chaetura* model at collecting insects quickly.

Cypsiurus (*Old World Palm Swift*).—*Cypsiurus parvus* was for a long time placed in the same genus (*Tachornis*) as the West Indian Palm Swift, *T. phoenicobia*. Yet although I have brought two other American birds, *Reinarda squamata* and *Micropanyptila furcata*, into *Tachnornis*, I have retained *Cypsiurus* as a separate monotypic genus. *C. parvus* particularly resembles *C.* (*Micropanyptila*) *furcata*, since it has the toes opposed in pairs and bare of feathers and a long, forked tail. Nevertheless, I think it probable that *Cypsiurus* is more closely related to *Apus* than to *Tachornis* and that its resemblances to the latter are the result of convergence. As already mentioned, it differs from *Tachornis* in having dark underparts and, more strikingly, in nesting habits.

The nest is a simple strip of feathers or plant fibres, about one and a half inches across, with a small projecting rim at the bottom (Sclater and Moreau, 1932; Townley, 1936; Chapin, 1939, citing many other references; Moreau, 1941). In shape, it resembles the bowl of a spoon, with the longer axis vertical, and it is attached to the vertical side of a a hanging palm leaf cn the inner (technically the under) side. Hence the nest is not placed in a narrow tube formed by hanging leaves, it is not sac-shaped, and the entrance is not at the bottom, as it is in *Tachornis*. Further, in *Cypsiurus* the eggs are stuck to the nest with saliva, an adaptation not found (or needed) in *Tachornis phoenicobia* or *T. squamata* with their sac-shaped nests (Belcher and Smooker, 1936; *cf*. Sick, 1947, 1948). The female *Cypsiurus* incubates in a vertical position (Moreau, 1941). The nestling hatches naked like other swifts, but develops down, which, so far as known, is not found in *Tachornis* or any other swift except *Hemiprocne*. The clutch is two or three. It may be added that *Cypsiurus*, like so many other swifts, has adapted its nesting habits to man, and in Asia it often nests in the roofs of native houses, especially those made of palm leaves or thatch (Baker, 1934).

As already mentioned, *Hemiprocne* resembles *Cypsiurus* in attaching the egg with saliva, in having nestling down, and in its long forked tail, but all these resemblances can be attributed to convergence.

Aëronautes (*White-throated and allied Swifts*).—As already mentioned, *Aëronautes saxatilis* was separated from *Apus* because its toes are somewhat feathered. It was later found that another American species, *montivagus*, until then placed in *Apus*, had some feathering on the toes, so it also was transferred to *Aëronautes*. This left only one American species, *andecolus*, in the genus *Apus*, and as already discussed, I consider that this likewise belongs to *Aëronautes*. This makes *Aëronautes* hard to define, since *andecolus* has unfeathered toes. The two main differences from *Apus* are the New World distribution and the presence of white on the underparts (though *Apus melba* has mainly white underparts). Also, Ridgway (1911) pointed out that in *Aëronautes saxatilis* the tail is moderately forked, but the outermost pair of rectrices is only slightly longer than the next pair. This also holds for *A. andecolus* (I have not seen *A. montivagus*) and it further helps to separate *Aëronautes* from *Apus*, since in many species of *Apus* the outermost pair of rectrices is decidedly longer than the next pair; but *Apus affinis* is an exception, with a nearly square tail, and the difference is small in some of the other species (Lack, *in press*).

Aëronautes consists of three species, all found on the western side of

America, and mainly between the high mountains and the sea. Their plumage is dark with patches or bands of white. In *A. montivagus*, which is the smallest and darkest species, white occurs on the throat and lower abdomen, while the breast and center of the abdomen are whitish. In *A. saxatilis*, white occurs on the throat and chest, the center of the upper abdomen, the flanks near the rump, and the tips of the secondaries. In *A. andecolus*, the whole of the underparts are white, and so are the neck and rump, including the flanks near the rump.

A. saxatilis builds in rock crevices on steep cliffs. It has also taken to using holes in buildings, occasionally in the old nest of a hirundine (Bent, 1940; Pitelka, 1944). The nest is a simple cup, which is sometimes attached to a vertical wall. The materials are feathers and dried vegetation. In all these respects, this species closely resembles the species of *Apus* (in which one species, *A. melba*, sometimes builds a bracket-nest on a vertical wall). But the recorded clutch of *A. saxatilis* is larger than that of *Apus*, being four, five, or six eggs (Bent, 1940; Bradbury, 1918; Rett, 1946). Since clutch-size is characteristic for each genus of Apodi, this reinforces the arguments given earlier for separating *Aëronautes* and *Apus*. The nests of *A. montivagus* and *A. andecolus* have not been found, but they are thought to be in holes in rocks in mountains (Taczanowski, 1884).

Panyptila (*Scissor-tailed Swifts*).—As discussed earlier, *Panyptila* stands between *Aëronautes*, which it strongly resembles in color pattern, and *Tachornis*, which it strongly resembles in nesting habits and to some extent in plumage. In color *Panyptila* is a rich glossy bluish black with white on throat and chest, nape, sides of rump, tips of secondaries, and a spot on each side of the forehead. The two species, *P. cayennensis* and *P. sancti-hieronymi*, differ only in size, but though allopatric they are placed in separate species. *P. sancti-hieronymi* breeds in Guatemala, also in Honduras (Carr and Dickinson, 1951) and probably in western Mexico (Selander, 1955). *P. cayennensis* occurs in eastern Mexico (Friedmann *et al.*, 1950) and to the south of the range of *P. sancti-hieronymi*, occurring over much of northern South America. The difference in size is remarkable for two forms otherwise so similar; Ridgway (1911) gives the wing-length of *P. cayennensis* as 116–120 mm. and that of *P. sancti-hieronymi* as 180–195 mm.

Panyptila builds an extraordinary nest, a long tubular structure which may be over two feet long even in the smaller species, though sometimes as short as seven inches. The entrance is at the lower end, and the eggs are in a lateral pocket or shelf near the top of the tube,

which is wider than the rest. In both species the nest is suspended under either a high branch of a tree or an overhanging rock. The material consists of dried feathery tufts of plant seeds and often of feathers, and the whole is worked with saliva into a close felt. (For *P. sancti-hieronymi*, see Salvin, 1863; Salvin and Godman, 1888–1904; Carr and Dickinson, 1951: for *P. cayennensis*, see Sclater, 1897; Richmond, 1898; Williams, 1922; Belcher and Smooker, 1936; Sick, 1947). The original nest described by Salvin apparently had a false entrance, but this has not been mentioned by any other observer.

Panyptila, like other swifts, nests in a hole, but the hole is of its own construction. Like other swifts, also, it has taken to nesting on buildings, *P. cayennensis* hanging its nest from the ceilings of houses (Sclater, 1897; Beebe, 1910; Williams, 1922; Greenway, 1934). The nest described by Beebe was alongside that of a wasp, but other observers have not mentioned this, so it may have been a chance association. *Panyptila* further resembles other swifts in using the same site in successive years, an extra shelf being added to the same tube (Belcher and Smooker, 1936). One nest of *P. cayennensis* contained three eggs (Belcher and Smooker, 1936); a group of three young of *P. sancti-hieronymi* brought to Carr suggests that the clutch of this species may also be three (Carr and Dickinson, 1951). The birds are also said to use the nest for shelter during rain (Salvin, 1863; Salvin and Godman, 1888–1904; Richmond, 1898).

Tachornis (*New World Palm Swifts*).—As already mentioned, I consider the species listed by Peters as *Tachornis phoenicobia*, *Micropanyptila furcata*, and *Reinarda squamata* to be more closely related to each other than to any other swifts and therefore think it desirable to unite them in one genus, instead of having three monotypic genera. As can be seen from the following notes, they show various resemblances to each other (and at times also to *Panyptila*) in both color pattern and nesting habits.

All three species have the toes opposed in pairs, but *T. squamata* differs from the other two in having feathered, not bare, toes (which links it with *Panyptila*, in which, however, all the toes point forward). The tail is strongly forked in *T. squamata* and *T. furcata* (also in *Panyptila*), but weakly forked in *T. phoenicobia*. The upper parts are glossy blue-black in *T. squamata* (thus linking it with *Panyptila*), but the feathers have white edges; the upper parts are rather glossy in *T. furcata*, dull sooty in *T. phoenicobia*. The underparts of all three species are pale, darker on the flanks, while *T. furcata* and *T. phoenicobia* have a dark bank across the chest. The rump is dark in *T. squamata* and *T. furcata*, but white on the sides in *T.*

phoenicobia (recalling *Panyptila*). The secondaries are narrowly tipped with white in *T. furcata* (recalling the broad white tips of *Panyptila*). (I have taken the description of *T. furcata* from Sutton, 1928.)

T. squamata nests in the long tube formed by the hanging leaves of a palm (Belcher and Smooker, 1936; Sick, 1948). In design, as pointed out by Sick, the nest closely resembles the hanging pocket or shelf which forms the upper part of the tubular nest of *Panyptila*, but the lower part of the tube is, in *T. squamata*, part of the plant, and is not made by the bird. The nest is a thin-walled sac, but the feathers are not worked into a felt, so that from outside it looks like a loose bundle of feathers. The entrance is from below. The clutch is "usually 3" (Belcher and Smooker, 1936; and one record by Sick, 1948). *T. phoenicobia* likewise builds a globular nest with the entrance at the bottom, placed in a hollow palm spathe or under a drooping palm frond, and it is made of vegetable fibres or feathers, compacted into a felt (as in *Panyptila*). The clutch is two or three (Gosse, 1847; Bond, 1936). The nest of *T. furcata* is unknown.

The critical taxonomic characters.—The foregoing review indicates that some of the morphological characters previously relied upon for classifying swifts give misleading results. In particular, the furcation of the tail and the feathering of the toes seem highly modifiable, and the species which share these characters need not be closely related. Even the position of the toes in opposed pairs has probably been evolved independently in two groups. It is not that morphological characters as such are likely to give misleading results, but that various earlier workers have given too much weight to single characters considered in isolation. Certain morphological characters, such as the diastataxic wing in *Cypseloides*, taken together with other features, have proved valuable in delimiting genera.

Color pattern has often been considered a less reliable guide than morphological characters in delimiting genera and in determining the relationships between genera, but in swifts it tends to be characteristic for each main group of species. Presumably, in the Apodi, the color of the plumage has been more conservative in evolution than have various morphological features affecting toes and tail. Thus similarity in color helps to unite all the species here placed in *Cypseloides*, it links the African species of *Chaetura* (two of which were formerly separated in *Mearnsia*), it relates *Apus affinis* to the other members of that genus, it helps in the transference of *andecolus* from *Apus* to *Aëronautes*, and it shows the affinity between *Aëronautes* and *Panyptila*.

Size is not a good taxonomic character in swifts and within some genera, such as *Chaetura*, *Apus*, and *Panyptila*, it is very variable.

The evidence from geographical range supports conclusions based on color pattern, notably in bringing *andecolus* into *Aëronautes* and in separating *Cypsiurus parvus* from *Tachornis*. Most of the genera are restricted to the New or the Old World, while in *Chaetura*, which occurs in both, the species of the New World seem more closely related to each other than to any of those in the Old World.

Nesting habits have proved an extremely useful guide. By themselves they might be as untrustworthy as any other character taken singly for denoting affinities, but in the Apodi they strikingly support the evidence of plumage, of some morphological characters and of geographical range, in the division of the group into nine genera as in this paper. More surprisingly, clutch-size has also proved characteristic for each genus. The nesting habits of each genus are summarized in Table 1.

TABLE 1. NESTING HABITS OF SWIFTS

Genus	*Situation*		*Shape*	*Main material*	*Typical clutch*
	general	*particular*			
Hemiprocne	small high branch	on top	tiny cup	bark and feathers	1
Cypseloides	rocks by water	vertical surface	large cone	mud and moss fern tips	1 (2)
Collocalia	cave	vertical surface	bracket	saliva plant fibres feathers	(1) 2
Chaetura	hollow tree	vertical surface	bracket	twigs	3 to 5
Apus	cliffs	crevice	open cup	plant fibres and feathers	2 to 3
Cypsiurus	palm leaf	vertical surface	shallow shelf	plant fibres and feathers	2 to 3
Aëronautes	cliffs	crevice	open cup	plant fibres and feathers	4 to 5
Panyptila	rock or high branch	suspended under	long tube	plant fibres and feathers	3
Tachornis	folded palm leaves or spathe	up long tube	sac	plant fibres and feathers	2 to 3

It is interesting to find that Mayr and Bond (1943) in classifying the swallows (Hirundinidae) reached a similar general conclusion for this group, namely that nesting habits are a valuable taxonomic character, while the feathering of the tarsus and the furcation of the tail are highly untrustworthy in delimiting genera. In the Hirundinidae, color pattern is in various respects unreliable, though these authors stress its general helpfulness in the classification of genera.

Geographical conspectus.—*Chaetura* is the most widespread genus of swifts, with breeding species in most of America (including the Nearctic), in the southern half of Africa, in Asia (including the Palaearctic), and in New Guinea. *Apus* is fairly widespread, with breeding species in the Palaearctic, in Africa, and in tropical Asia. The other genera are much more confined, *Hemiprocne* to southeastern Asia and adjoining archipelagoes, *Cypseloides* to tropical America with one species in northwest America, *Collocalia* to southeastern Asia and the islands of the Indian and Pacific oceans, *Cypsiurus* to tropical Africa and Asia, *Aëronautes* to the western mountains and seaboard of America, *Panyptila* and *Tachornis* to tropical America.

Only six species of swifts breed in appreciable numbers north of about latitude 50° N., *Apus apus* in Europe and western Asia, *Chaetura caudacuta* and *Apus pacificus* in eastern Asia, *Chaetura (p.) pelagica* in eastern North America, *Cypseloides niger* and *Chaetura (p.) vauxi* (and perhaps *Aëronautes saxatilis*) in western North America. These migrate south for the winter.

Most of the world's swifts are found in, and many are confined to, the tropics. Thus the mainland of tropical Africa supports 17 species (5 of *Chaetura*, 11 of *Apus*, 1 of *Cypsiurus*) and Madagascar and the Seychelles bring in 2 more (1 of *Collocalia*, 1 of *Chaetura*). Tropical Asia supports more than 20 species (3 of *Hemiprocne*, perhaps 10 of *Collocalia*, 5 of *Chaetura*, 3 of *Apus*, 1 of *Cypsiurus*). Tropical America, again, has 22 species (9 of *Cypseloides*, 5 of *Chaetura*, 3 of *Aëronautes*, 2 of *Panyptila*, 3 of *Tachornis*). In any one tropical country, however, there are at least as many species in Africa as elsewhere, as more of the Asiatic and American species replace each other geographically. Thus the number of breeding species in Mexico is 7 (Friedmann *et al.*, 1950), Colombia 10 (de Schauensee, 1948–49), Venezuela about 11 (that number has been recorded, but not all breeding at Rancho Grande alone, Schäfer and Phelps, 1954), former British India 11 (Baker, 1934), the whole of Malaysia including many archipelagoes 12 (Delacour, 1945), the Union of South Africa 9 (based on Roberts, 1940), Kenya about 11 (Praed and Grant, 1953), and the Belgian Congo about 15 (Chapin, 1939). Some of these figures are approximate as the exact status of some species is doubtful. In Kenya, Meinertzhagen (1937) once shot nine different forms from a single flock.

New Guinea, so rich in certain kinds of birds, has only 6 breeding species of swifts (1 of *Hemiprocne*, 4 of *Collocalia*, 1 of *Chaetura*). Surprisingly, Australia is almost devoid of resident swifts. Two species of *Collocalia* breed in the extreme northeast and that is all,

though two migrants from Asia, *Chaetura caudacuta* and *Apus pacificus*, are widespread in winter.

Size limits.—The smallest swifts are found in the genera *Collocalia* and *Tachornis*, with wing-lengths around 90 mm., while the largest are *Hemiprocne mystacea*, the *Streptoprocne* section of *Cypseloides*, the *Hirund-apus* section of *Chaetura*, and *Apus melba*. In three species, *Hemiprocne mystacea*, *Cypseloides semicollaris*, and *Apus melba*, the wing-length may exceed 230 mm. It may be tentatively suggested that these size limits are imposed by the food supply. For catching very small insects, it is perhaps less necessary to travel so fast through the air but more necessary to be able to check and turn in flight. Anyway, below the lower limit of size in swifts, the swallows (Hirundinidae) take over, with their shorter and less specialized wing, slower speed but greater ability to check and turn. At the other extreme, swifts larger than those that exist might be unable to find enough large insects that are air-borne in daytime, at least during part of each year. Many larger insects take wing at night, but at dusk the nightjars (Caprimulgidae) take over, many of which are larger than swifts, while they also possess a greater ability in turning and hovering, and the eyes are modified for seeing in a dim light.

Summary.—1. The Apodi are here classified in 9 genera as follows, the number of species being placed in brackets: *Hemiprocne* (3), *Cypseloides* (9), *Collocalia* (not specified), *Chaetura* (17), *Apus* (10), *Cypsiurus* (1), *Aëronautes* (3), *Panyptila* (2), *Tachornis* (3). (See check-list which follows.)

2. The main changes from Peters are (i) a return to Hartert's (later Zimmer's) arrangement of *Cypseloides* but with the addition of *Streptoprocne*, (ii) the transfer of *andecolus* from *Apus* to *Aëronautes*, (iii) the grouping of *Reinarda* and *Micropanyptila* in *Tachornis*.

3. Color pattern is a helpful taxonomic character in swifts, but the furcation of the tail and the feathering of the toes are highly modifiable.

4. The situation and construction of the nest are characteristic for each genus, and so is clutch-size (See Table 1).

5. Many species now nest on buildings, including *Collocalia* (2 spp.), *Chaetura* (5 spp.), *Apus* (6 spp.), *Cypsiurus* (1 sp.), *Aëronautes* (1 sp.), and *Panyptila* (1 sp.).

CHECK-LIST OF APODI

The changes from Peters (1940) are indicated in brackets. I have also changed Peters' order, conforming to the modern practice of putting first those genera with more primitive features.

HEMIPROCNIDAE

Hemiprocne (Crested Swifts)

longipennis
mystacea
comata

APODIDAE

CHAETURINAE

Cypseloides (Primitive Swifts or Black Swifts)

zonaris (transferred from *Streptoprocne*)
biscutatus (transferred from *Streptoprocne*)
semicollaris (transferred from *Aërornis*)
senex (transferred from *Aërornis*)
rutilus (transferred from *Chaetura*)
fumigatus
cherriei
cryptus (described by Zimmer, 1945)
niger (transferred from *Nephoecetes*)

Chaetura (Spine-tailed Swifts)

(i) *pelagica* (tentatively including *vauxi, gaumeri, richmondi, chapmani*)
cinereiventris (tentatively including *martinica*)
spinicauda
andrei
brachyura
(ii) *sabini* (including *thomensis*)
ussheri
melanopygia
cassini
böhmi
sylvatica
leucopygialis
grandidieri
(iii) *caudacuta*
(*cochinchinensis*?) (see Biswas, 1951)
gigantea
(iv) *picina*
novaeguineae

Collocalia (Cave Swiftlets) (species not listed)

APODINAE

Apus (Typical Swifts)

apus (including *unicolor* and *alexandri*)
barbatus (including *sladeniae, balstoni, mayottensis* and *bradfieldi*)
pallidus (including *niansae*)

aequatorialis (including *reichenowi*)
melba
myoptilus (including *poensis* and *batesi*)
caffer
horus (including *toulsoni*)
affinis
pacificus (including *acuticaudus*)
Cypsiurus (Old World Palm Swift)
parvus
Aëronautes (White-throated and allied swifts)
saxatilis
montivagus
andecolus (transferred from *Apus*)
Panyptila (Scissor-tailed Swifts)
sancti-hieronymi
cayennensis
Tachornis (American Palm Swifts)
phoenicobia
furcata (transferred from *Micropanyptila*)
squamata (transferred from *Reinarda*)

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ECOLOGICAL STUDY OF RUFFED GROUSE BROODS IN VIRGINIA

BY ROBERT E. STEWART

THE RUFFED GROUSE (*Bonasa umbellus*), commonly called "pheasant" throughout the southern Appalachian region, is a popular game bird in the mountains of Virginia. Unfortunately, however, the grouse populations in this State have declined noticeably during the past fifty years. Because of this, special field studies were designed through the cooperation of the U. S. Fish and Wildlife Service and U. S. Forest Service, which would provide information that could be used in devising more efficient grouse management practices. As part of this program, I was assigned to investigate the ecology and habits of this species in the Shenandoah Mountains during the spring and summer of 1941. These studies were conducted within the George Washington National Forest in northwestern Augusta County, southwestern Rockingham County, and northeastern Highland County, Virginia.

Special attention was given to the habitat requirements and behavior of young grouse from May 28, when the first brood was found, until the end of July. Concentrated effort toward this phase of the study resulted in a total of 98 contacts with grouse broods. In addition to information on broods, analyses of crop and stomach contents of 29 grouse chicks produced information on food habits.

Acknowledgment is made to A. L. Nelson, Director of the Patuxent Research Refuge and to Talbott E. Clarke (deceased), formerly of the U. S. Forest Service, for their helpful advice. I am also indebted to Robert H. Gensch for the analysis of food contents from 12 grouse chicks, including 6 that were collected by him. Special thanks are due Dr. A. C. Martin and L. W. Saylor for their assistance in the identification of most of the more difficult items of food. The scientific names of plants mentioned in this report are those of Gray's Manual of Botany (Fernald, 1950).

Habitat.—Most grouse broods were found in lowland areas along streams in coves or ravines, or on the higher knobs and ridges at elevations above 4000 feet during the first few weeks following hatching, in late May, June, and early July. These situations support moist types of forest and altogether do not comprise more than 15 per cent of the total forest land in the Shenandoah Mountains. Small areas of moist forest also occur locally on steep north slopes, but this type of terrain is apparently shunned by broods. The forest type found along streams in the coves or ravines, and on steep north slopes,

probably could be classified as the Mixed Mesophytic Forest Association (Braun, 1950). The more important trees in this type include: hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), sweet birch (*Betula lenta*), white oak (*Quercus alba*), red oak (*Quercus rubra*), tulip poplar (*Liriodendron tulipifera*), sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), basswood (*Tilia* sp.), and black gum (*Nyssa sylvatica*). On the higher ridges and knobs, the forests are composed chiefly of red oak and sweet birch, while a fairly dense sprout-growth of chestnut (*Castanea dentata*) is also characteristic.

Broods of young grouse were scarce or absent during early summer on most slopes, ridges, and knobs at elevations below 4000 feet. These areas, comprising the most extensive portion of the Shenandoah Mountains, are covered with a much drier type of forest, in which various species of oaks are usually predominant. According to Braun's (1950) classification, this forest probably would be considered as part of the Oak-chestnut Forest Association. Chestnut oak (*Quercus prinus*) and scarlet oak (*Quercus coccinea*) are abundant over much of this area. Locally, and especially on southern and western slopes, scrub pine (*Pinus virginiana*), pitch pine (*Pinus rigida*), and Table Mountain pine (*Pinus pungens*) are common, while extensive tracts of scrubby bear oak (*Quercus ilicifolia*) occur on some of the more level expanses.

Intermediate moisture conditions were found to exist in the forests on the broader valley floors and occasionally on eastern slopes. These forests were composed chiefly of white oak, black oak (*Quercus velutina*), and various hickories (*Carya* spp.), while locally, nearly pure stands of white pine were found. During the early summer, a few scattered broods were located in these areas, although they were much less common there than in the forests of the ravines and high ridges and knobs.

Practically all broods of the younger grouse were found in or near forest-edge habitats. Most of them were distributed within the moist forest types along small or narrow semi-shaded clearings, such as secondary roads, wagon-roads, trails, and natural forest openings. The preference for these situations is probably due to the more luxuriant growth of ground vegetation that characteristically develops on them. The relative abundance of young woody sprouts and seedlings appeared to be especially important. While a few broods were found in openings almost entirely devoid of this type of plant-growth, it was noticed that areas which supported the greatest number of broods were those in which many recent small clearings or slashings had resulted in an abundance of woody sprouts. The

outstanding area supporting this observation was found in Ramsey's Draft in Augusta County, where 26 brood contacts were made. A newly constructed road extended for over four miles up this cove, and along its margins, sprouts and seedlings of the more succulent types of trees were found in abundance, including such species as sweet birch, tulip poplar, cucumber tree (*Magnolia acuminata*), sugar maple, and basswood. This lush growth of small woody plants, undoubtedly served as a rich source of insect food near the ground within reach of small chicks and at the same time provided excellent protective cover for them.

In Table 1, the various species of plants found in the environs of 90 brood contacts during late May, June, and early July were classified into four strata, designated as overstory. middlestory, understory, and ground cover. A rating system was devised in an attempt to evaluate the relative abundance of the component plant species for each vegetative layer. According to this system, the three most abundant species within each stratum were rated for every brood contact by assigning 3 points for the most abundant species, 2 points for the second most abundant species, and 1 point for the third most abundant species. These data, from all contacts, were then tabulated for each stratum by computing the percentage of total points comprised by each species. The tabulation represents a composite analysis of the vegetation of the grouse brood environment during late May, June, and early July.

Table 1 helps to illustrate the great variety of plants that are characteristic of Ruffed Grouse brood habitats in the Shenandoah Mountains. Most of the predominant species are those that are adapted to moist forest conditions. Many species, particularly in the understory and ground cover, are largely restricted to edge situations such as are found in small forest openings. The prominence of hemlock and white pine in the overstory is believed to be significant only to the extent that these species are characteristic of the moist forests of this region, since no preference for coniferous cover by broods was indicated.

An abrupt change was noted in the habitat preferences of broods following the first week of July. Whereas, previously, it was generally possible to locate at least one brood during a day's work in the field, thereafter it was difficult to locate more than two broods a week. The most significant change, however, was the almost total absence of broods in the moist forest areas, where they previously had been common. Nearly all of the broods were found instead in the drier forest associations of the mountain slopes. Only two broods were

TABLE 1

VEGETATION OF EARLY RUFFED GROUSE BROOD ENVIRONMENT

Overstory			
	per cent		*per cent*
Hemlock (*Tsuga canadensis*)	16	Sweet birch (*Betula lenta*)	5
White oak (*Quercus alba*)	13	Scarlet oak (*Quercus coccinea*)	4
Red oak (*Quercus rubra*)	11	Sugar maple (*Acer saccharum*)	4
Red maple (*Acer rubrum*)	10	Basswood (*Tilia* sp.)	4
White pine (*Pinus strobus*)	8	Tulip poplar (*Liriodendron tulipifera*)	3
Hickories (*Carya* spp.)	8	Other (13 species)	14
Middlestory			
	per cent		*per cent*
Witch hazel (*Hamamelis virginiana*)	27	Hornbeam (*Carpinus caroliniana*)	5
Black locust (*Robinia pseudo-acacia*)	12	Serviceberry (*Amelanchier* sp.)	4
Chestnut (*Castanea dentata*)	10	Staghorn sumac (*Rhus typhina*)	4
Flowering dogwood (*Cornus florida*)	9	Alder (*Alnus* sp.)	3
Sassafras (*Sassafras albidum*)	8	Hawthorn (*Crataegus* sp.)	3
Striped maple (*Acer pensylvanicum*)	7	Other (10 species)	8
Understory (including vines)			
	per cent		*per cent*
Blackberry (*Rubus* sp.)	19	Poison ivy (*Rhus radicans*)	4
Mountain laurel (*Kalmia latifolia*)	16	Woodbine (*Parthenocissus quinquefolia*)	4
Rose (*Rosa* sp.)	10	Wild grape (*Vitis* sp.)	4
Greenbrier (*Smilax* sp.)	7	Thimbleberry (*Rubus odoratus*)	3
Wild hydrangea (*Hydrangea arborescens*)	7	Azalea (*Rhododendron* sp.)	3
Minnie bush (*Menziesia pilosa*)	5	Blueberry (*Vaccinium* sp.)	3
Dewberry (*Rubus* sp.)	4	Other (9 species)	11
*Ground Cover (Forbs)**			
	per cent		*per cent*
Cinquefoil (*Potentilla canadensis*)	24	Bedstraw (*Galium* sp.)	4
Violets (*Viola* spp.)	10	New York fern (*Dryopteris noveboracensis*)	3
Wood aster (*Aster divaricatus*)	10	Wood sorrel (*Oxalis stricta*)	3
Teaberry (*Gaultheria procumbens*)	5	Selfheal (*Prunella vulgaris*)	3
Wild strawberry (*Fragaria virginiana*)	4	Partridge berry (*Mitchella repens*)	3
Hog peanut (*Amphicarpa bracteata*)	4	Other (45 species)	23
Jewelweed (*Impatiens* sp.)	4		

* Ground cover also included numerous seedlings and sprouts of overstory species.

recorded in the moist cove forest during this period, and these were observed to ascend the adjacent slopes immediately after flushing, so that it is probable that they had returned to the cove merely for water. All of the broods located on the slopes were found in the vicinity of ripened blueberries. This fruit is largely restricted to the drier habitats and apparently is of major importance in relation to the distribution of grouse broods in late summer, since five chicks collected at this time had been feeding predominantly on it (see Table 3). It is also of interest to note that the change in habitat preference occurred at approximately the same time that blueberries began to ripen.

TABLE 2
GENERAL FOOD TYPES OF RUFFED GROUSE CHICKS
(FIGURES REPRESENT VOLUMETRIC PERCENTAGES)

	May 28– June 14 (*12 chicks*)	*June 18– June 30* (*12 chicks*)	*July 10– July 13* (*2 chicks*)	*August 5– August 25* (*3 chicks*)
Animal Food	(91)	(44)	(10)	(1)
Snails	4	5	+	–
Insect Larvae	34	23	2	–
Adult Insects	50	15	8	1
Misc. Animal Food	3	1	+	+
Plant Food	(9)	(56)	(90)	(99)
Small Seeds	1	44	18	–
Fleshy Fruits	8	6	67	63
Green Leaves	–	–	+	21
Misc. Veg. Matter	+	6	5	15
	100	100	100	100

Similar habitat requirements for Ruffed Grouse broods have been reported from studies made elsewhere in the United States, although important differences have also been noted in certain areas that contain entirely different types of biotic communities. King (1937) described the situation in Minnesota as follows: "Ideal brooding cover is a low, dense canopy adjoining openings that support a variety of plant and insect life . . . plants must be low-growing (ground cover) if they are to be available to the young, and the greater the variety of plants, the greater the number and kinds of insects and plant materials present." In New York Bump *et al.* (1947) found that broods prefer cover types in which the crown cover is sparse, and report further: "It is the early stages of woodland succession with their profusion of fresh herbaceous growth, that are attractive . . . where summer slopes are dry as in our Adirondacks, the moister alder beds are prime favorites . . . a strong tendency for young birds to favor flat lands and moderate slopes rather than steep hillsides." Edminster (1947) emphasizes the need in New York for brush openings, preferably of a hardwood type. In Ohio (Chapman *et al.*, 1948), broods were found to occur in ". . . slashing or brush area with small clearings where insects and fruits are plentiful and where brambles and greenbrier tangles offer protective cover." In northeastern Iowa (Polderboer, 1942), broods were found to frequent "clearings, trailsides and bramble patches in valleys and at the mouths of open ravines" during the first half of June; "in late June and throughout July, bramble patches and clearings on ridge tops were used." During the late summer in Michigan (Fisher, 1939), a tendency was found for "the female to keep young birds near the borders of coniferous swamps where it is much cooler and where more moisture accumulates

during the hot days of July and August." In northern Idaho, Hungerford (1951) describes the early brood habitat as "any kind of coniferous cover adjacent to clearings or openings on the ridges or upper slopes," while in late summer, he reports a movement to lower slopes and ravines.

In general, throughout the range of the Ruffed Grouse, broods during the early stages may be found in moist forest habitats that are typical of regions characterized by cool climates. In certain regions, such as the Great Lakes area and southeastern Canada, these habitat conditions are fairly extensive, and here Ruffed Grouse broods are quite generally distributed. In other regions including the southern Appalachians and Rocky Mountain area, the requisite habitat conditions are more local and restricted in area, and as a consequence Ruffed Grouse broods are somewhat "spotty" in their distribution. It would appear that the presence or absence of appropriate brood habitat conditions, is a major limiting factor concerning the geographical distribution of this species.

Food Habits.—The food of young grouse was determined from the analyses of the crop and stomach contents of 29 chicks, all of which were collected within the George Washington National Forest in Augusta, Highland, and Rockingham counties, during the years 1939 through 1941. Since out of the total number studied, only 2 chicks were collected from the same brood, the food analysis should be fairly representative, especially for the month of June. Although only 5 chicks had been collected in July and August, the analyses of their crop and stomach contents at least serve as an indication of feeding trends.

The data in Tables 2 and 3 indicate that the food of grouse chicks steadily changes from a diet during early June in which animal food is predominant to a diet in July and August that is composed chiefly of plant foods. The principal animal foods include the larvae of Tenthredinidae (sawflies) and Phalaenidae (loopers or measuring worms) and the adults of Coleoptera and Homoptera, particularly those belonging to the families Chrysomelidae (leaf beetles) and Membracidae (tree-hoppers). Numerous other insects as well as snails (Gastropoda) are also of some importance. During early summer the predominantly animal diet is supplemented with the fruits and seeds of such species as violet (*Viola* sp.), strawberry (*Fragaria* sp.), and sedge (chiefly *Carex laxiflora*). Fleshy fruits, especially blueberries (*Vaccinium* sp.), are of major importance in the late summer diet, while fungi (Agaricaceae) and the green leaves of ferns and other plants are also consumed in fair quantities at this time.

TABLE 3

SPECIFIC FOOD TYPES OF RUFFED GROUSE CHICKS
(FIGURES REPRESENT VOLUMETRIC PERCENTAGES)

	May 28– June 14 (*12 chicks*)	*June 18– June 30* (*12 chicks*)	*July 10– July 13* (*2 chicks*)	*August 5– August 25* (*3 chicks*)
Animal Food				
Gastropoda (Snails)	4	5	+	–
Insect Larvae				
Tenthredinidae (Sawflies)	24	11	1	–
Phalaenidae (Measuring Worms)	10	11	1	–
Lepidoptera (Butterflies, Moths)	+	1	–	–
Other	+	+	–	–
Adult Insects				
Coleoptera (Beetles)				
Chrysomelidae (Leaf Beetles)	12	1	+	–
Elateridae (Click Beetles)	1	2	1	+
Lampyridae (Fireflies)	1	1	1	–
Curculionidae (Snout Beetles)	1	+	+	+
Coccinellidae (Ladybirds)	1	+	+	–
Scarabaeidae (Scarabs)	1	+	+	–
Carabidae (Ground Beetles)	1	+	–	–
Other	+	1	1	–
Homoptera				
Membracidae (Tree-hoppers)	7	+	–	–
Aphididae (Aphids)	3	+	+	–
Cicadellidae (Leaf-hoppers)	1	+	1	–
Cercopidae (Spittle-bugs)	1	+	–	–
Aleyrodidae (Whiteflies)	1	–	–	–
Fulgoridae (Lanternflies)	1	–	–	–
Other	1	1	–	–
Hymenoptera				
Formicidae (Ants)	+	6	1	–
Ichneumonidae (Ichneumon Flies)	1	+	+	–
Other	+	–	–	–
Orthoptera				
Tettigoniidae (Long-horned Grasshoppers)	–	–	3	1
Locustidae (Short-horned Grasshoppers)	2	+	–	–
Plecoptera (Stoneflies)	3	1	–	–
Mecoptera (Scorpionflies)	4	–	–	–
Hemiptera				
Lygaeidae (Chinch Bugs)	1	1	+	–
Other	1	+	+	–
Diptera				
Empididae (Dance Flies)	1	+	–	–
Tipulidae (Crane Flies)	1	+	–	–
Other	1	+	+	–
Heterocera (Moths)	1	1	–	–
Trichoptera (Caddiceflies)	1	+	–	–
Misc. Animal Food				
Araneae (Spiders)	2	1	+	+
Phalangida (Harvestmen)	1	–	+	+
Insect Eggs and Pupae	+	+	–	–
Plant Food				
Small Seeds				
Violet (*Viola* sp.)	+	28	+	–
Sedge (*Carex* sp.)	+	15	18	–

TABLE 3—*Continued*

	May 28–June 14 (*12 chicks*)	*June 18–June 30* (*12 chicks*)	*July 10–July 13* (*2 chicks*)	*August 5–August 25* (*3 chicks*)
Plant Food—Continued				
Rue Anemone (*Anemonella thalictroides*)	1	–	–	–
Other	+	1	+	–
Fleshy Fruits				
Strawberry (*Fragaria* sp.)	8	4	–	–
Service-berry (*Amelanchier* sp.)	–	2	+	–
Blueberry (*Vaccinium* sp.)	–	+	67	63
Other	+	+	+	+
Green Leaves				
Bracken Fern (*Pteridium aquilinum*)	–	–	–	16
New York Fern (*Dryopteris noveboracensis*)	–	–	–	3
Sweet Golden-rod (*Solidago odora*)	–	–	–	2
Other	–	–	+	–
Misc. Plant Food				
Fungi (Agaricaceae)	–	2	5	15
Flowers and Twigs of Mt. Laurel (*Kalmia latifolia*)	–	2	–	–
Fragments of Acorns (*Quercus* sp.)	–	2	–	–
Misc. Flowers, Buds, and Twigs	+	+	–	+

General food habits studies of grouse chicks by Judd (1905), as well as local studies in New York (Bump *et al.*, 1947) and Wisconsin (Grange, 1948) show that similar types of food are taken elsewhere within the range of the Ruffed Grouse. A noticeable shift during the summer from a diet of animal food to plant food is also indicated. The late summer diet in New York, however, differed in that blackberries and raspberries were taken in large quantities, while blueberries were of minor importance.

Summary.—In the Shenandoah Mountains of Virginia, broods of young Ruffed Grouse during late May, June, and early July were found to be largely restricted to the moist forests of the ravines and to similar forest types on the higher knobs and ridges at elevations above 4000 feet. A definite preference was shown for forest-edge situations such as are found along small or narrow semi-shaded clearings including secondary roads, wagon-roads, trails, and natural forest openings. They were found to be most numerous along the margins of openings with an abundance of herbaceous plants, woody sprouts, and seedlings. In late summer following the first week in July, a marked change occurred in their habitat distribution. At this time they were found scattered in the more extensive, drier forest associations of the mountain slopes, where ripened blueberries abound. Apparently similar habitat conditions are required by broods elsewhere within the range of this species.

The food of grouse chicks steadily changes from a diet that is composed predominantly of animal matter in early June to one that is largely vegetarian in July and August. The principal animal foods include the larvae of Tenthredinidae (sawflies) and Phalaenidae (loopers or measuring worms) and the adults of Chrysomelidae (leaf beetles) and Membracidae (tree-hoppers). Numerous other insects as well as snails (Gastropoda) are also of some importance. The chief vegetable foods during the early summer include the fruits and seeds of strawberries (*Fragaria* sp.), violets (*Viola* sp.), and sedges (*Carex* sp.). In late summer, fleshy fruits, especially blueberries (*Vaccinium* sp.), are consumed in large quantities, and these are supplemented to a considerable extent with fungi (Agaricaceae) and the green leaves of ferns and other herbaceous plants.

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Patuxent Research Refuge, Laurel, Maryland, January 18, 1954.

VARIATIONS IN EGG CHARACTERISTICS OF THE HOUSE WREN

BY S. CHARLES KENDEIGH, THEODORE C. KRAMER, AND FRANCES HAMERSTROM

THERE are scattered records in the literature showing that the weights of consecutively laid fresh eggs or their measured lengths and maximum diameters may either decrease or increase in different species. In a statistical analysis of 20 clutches in the Laughing Gull (*Larus atricilla*), Preston and Preston (1953) showed that the length measurement did not differ significantly either among the eggs of the same clutch or between the eggs of different clutches. On the other hand, in three-egg clutches the third egg laid had a significantly smaller diameter than the first two. In two-egg clutches, the second egg appeared to resemble the third more than the second in the three-egg clutches, but the small number of measurements available did not permit definite conclusions.

Since a large series of data had been collected at the Baldwin Bird Research Laboratory, near Cleveland, Ohio, between 1925 and 1938, on the eggs of the House Wren (*Troglodytes aëdon*), we decided to determine whether or not there were any consistent changes in dimensions and weight with sequence of laying in this passerine species. Comparable data have been obtained for only one other passerine species, the Song Sparrow, *Melospiza melodia* (Nice, 1937).

S. C. Kendeigh of the University of Illinois is chiefly responsible for the statistics and for making the biological interpretations, T. C. Kramer of the University of Michigan collected much of the raw data, Frances Hamerstrom of the Wisconsin Conservation Department provided the original data for the experiments conducted by Dr. Leon J. Cole and for her own experiments in trying to force House Wrens to lay additional eggs. An early draft of the manuscript was read, important suggestions were offered, and help with the statistics was given by Dr. F. W. Preston and Mary E. Gemperle of the Preston Laboratories, Butler, Pennsylvania, by Dr. Alexis L. Romanoff of Cornell University, by Dr. H. M. Scott of the University of Illinois, and by Dr. David E. Davis of Johns Hopkins University. This paper is contribution number 45 of the Baldwin Bird Research Laboratory.

Materials and procedure.—The length and greatest diameter of the eggs were measured at the Baldwin Laboratory to 0.01 mm. with a Palo micrometer caliper equipped with a ratchet stop and adjustment screw. Each egg was numbered as laid so that the sequence of laying could be determined. All weights were obtained on the same day

that the eggs were laid, usually within six hours. The eggs were weighed to 1 mg., generally on a chainomatic balance. Usable data are available on egg dimensions in sequence of normal laying for 29 clutches and on egg weights for 52 clutches. Egg measurements were obtained on 195 additional clutches where the sequence of laying was not known. Data are presented on forced laying experiments for eight females.

TABLE 1

AVERAGE LENGTH (IN MILLIMETERS) OF HOUSE WREN EGGS, WITH STANDARD DEVIATIONS

	Clutch Size			
Position in sequence	*4 (2 clutches)*	*5 (11 clutches)*	*6 (13 clutches)*	*7 (3 clutches)*
1	16.08	16.80 ± 0.92	16.54 ± 1.10	16.08
2	15.95	16.75 ± 0.45	16.33 ± 0.68	16.82
3	16.31	16.83 ± 0.46	16.78 ± 0.57	16.59
4	16.58	17.03 ± 0.61	16.62 ± 0.52	16.96
5		17.12 ± 0.62	16.84 ± 0.47	16.60
6			17.12 ± 0.59	16.72
7				17.11
Total increase first to last egg	0.50	0.32	0.58	1.03
Average increase per egg	0.167	0.080	0.116	0.172
Per cent average increase per egg	1.03	0.47	0.69	1.03

Length.—Table 1 gives the average length of each egg according to its ordinal position in the clutch and according to the size of the clutch. Although there is some irregularity among the early eggs laid, the penultimate egg averages longer than the third from the last in each clutch and the last egg longer than the penultimate. There appear to be no statistically reliable differences between clutches in

TABLE 2

AVERAGE BREADTH (IN MILLIMETERS) OF HOUSE WREN EGGS, WITH STANDARD DEVIATIONS

	Clutch Size			
Position in sequence	*4 (2 clutches)*	*5 (11 clutches)*	*6 (13 clutches)*	*7 (3 clutches)*
1	12.46	12.78 ± 0.49	12.54 ± 0.38	12.41
2	12.65	12.74 ± 0.31	12.58 ± 0.36	12.71
3	12.76	12.77 ± 0.22	12.73 ± 0.30	12.69
4	12.84	12.84 ± 0.29	12.81 ± 0.32	12.53
5		12.90 ± 0.31	12.85 ± 0.32	12.48
6			12.89 ± 0.32	12.76
7				12.94
Total increase first to last egg	0.38	0.12	0.35	0.53
Average increase per egg	0.127	0.030	0.070	0.088
Per cent average increase per egg	1.02	0.23	0.55	0.69

the total increase from first to last egg, the average increase per egg, or the per cent average increase per egg when all size clutches are included. However, if the four-egg clutches are excluded, all three calculations of increase from first to last egg become greater as the size of the clutch increases.

TABLE 3

RESULTS OF ANALYSES OF VARIANCE FOR LENGTH OF EGGS IN 24 COMBINED FIVE- AND SIX-EGG CLUTCHES

		First and third eggs	*First and last eggs*	*Third and last eggs*
Computed variance ratio	Sequence	0.64	4.80	17.7
	Parentage	2.29	1.56	7.86
F value for 1 per cent level	Sequence	7.88	7.88	7.88
	Parentage	2.72	2.72	2.72
F value for 5 per cent level	Sequence	4.28	4.28	4.28
	Parentage	2.01	2.01	2.01
Significance	Sequence	No	Barely	Yes
	Parentage	Barely	No	Yes
Variability	Sequence	—	1.0162	0.5768
	Parentage	0.0208	0.0124	0.0197
	Error	0.3869	0.5346	0.0689
	Total	0.4077	1.5632	0.6654
Partition of variability (per cent)	Sequence	—	65.0	86.7
	Parentage	5.1	0.8	3.0
	Error	94.8	34.2	10.3
Coefficient of variation (per cent)	Sequence	—	6.0	4.5
	Parentage	3.7	0.7	0.8
	Error	0.9	4.3	1.5
Mean value of characteristic for	First egg	16.66	16.66	—
	Third egg	16.80	—	16.80
	Last egg	—	17.12	17.12
	All eggs	16.73	16.89	16.96

Breadth.—Contrary to what was found in the Laughing Gull, the last egg in clutches of the House Wren is the largest in diameter (Table 2). As with length, there is some irregularity in the first eggs of each clutch, but the penultimate and last eggs average greater in breadth than the next preceding ones. If the four-egg clutches are excluded, there is an increase from five- to six- to seven-egg clutches in the total increase in breadth from first to last egg, in average increase per egg, and in per cent average increase per egg. However, if the four-egg clutches are included the differences are not significant.

Analysis of variance for length and breadth.—The standard deviations of both length and breadth as given in Tables 1 and 2 may be due in part to differences between individuals laying the eggs. An analysis of variance was therefore made according to (1) the bird that laid the egg or "parentage," (2) the position of the egg in the clutch sequence, and (3) a variety of other causes or "error." This

is the same basis used by Preston and Preston (1953) for the eggs of the Laughing Gull, and both terminology and method of analysis are similar.

Considering only the 24 five- and six-egg clutches and only the first, third, and last egg, it was found that neither the length nor the breadth differed significantly at the one per cent level between the first and third egg in the sequence, but that the length and breadth of the third egg differed significantly from the last egg (Tables 3 and 4). The influence of parentage on length and breadth was relatively small.

TABLE 4

RESULTS OF ANALYSES OF VARIANCE FOR BREADTH OF EGGS IN 24 COMBINED FIVE- AND SIX-EGG CLUTCHES

		First and third eggs	*First and last eggs*	*Third and last eggs*
Computed variance ratio	Sequence	1.57	11.15	14.17
	Parentage	2.59	3.58	8.33
F value for 1 per cent level	Sequence	7.88	7.88	7.88
	Parentage	2.72	2.72	2.72
F value for 5 per cent level	Sequence	4.28	4.28	4.28
	Parentage	2.01	2.01	2.01
Significance	Sequence	No	Yes	Yes
	Parentage	Barely	Yes	Yes
Variability	Sequence	0.0213	0.3223	0.1159
	Parentage	0.0049	0.0121	0.0538
	Error	0.0745	0.0635	0.0176
	Total	0.1007	0.3979	0.1873
Partition of variability (per cent)	Sequence	21.0	81.0	61.9
	Parentage	5.0	3.0	28.7
	Error	74.0	16.0	9.4
Coefficient of variation (per cent)	Sequence	1.2	4.5	2.6
	Parentage	0.6	0.9	1.8
	Error	2.2	2.0	1.0
Mean value of characteristic for	First egg	12.65	12.65	—
	Third egg	12.75	—	12.75
	Last egg	—	12.89	12.89
	All eggs	12.70	12.77	12.82

Shape.—No detailed data are available on the shape of the eggs, but it will probably be near enough for our calculations to take them as being prolate ellipsoids, that is, spheres elongated along one axis. The only index of shape we have at our disposal is the ratio of maximum diameter to length. An increase in the value of this ratio indicates that the egg is relatively shorter and broader and a decrease in the index indicates that the egg is longer in proportion to its breadth. It appears from Table 5 that in all except the seven-egg clutches the second from the last and the last eggs show a progressively smaller index value. This means that although the last two eggs increase

TABLE 5

INDEX OF SHAPE ACCORDING TO THE FORMULA: $100 \cdot \frac{\text{breadth}}{\text{length}}$

Position in sequence	*Clutch size* 4 (2 clutches)	5 (11 clutches)	6 (13 clutches)	7 (3 clutches)
1	77.49	76.07	75.82	77.18
2	79.31	76.06	77.04	75.56
3	78.23	75.88	75.86	76.49
4	77.44	75.40	77.08	73.88
5		75.35	76.31	75.18
6			75.29	76.32
7				75.63

TABLE 6

AVERAGE WEIGHTS (IN GRAMS) OF NEW-LAID EGGS, WITH STANDARD DEVIATIONS

Position in sequence	*Clutch size* 4 (6 clutches)	5 (16 clutches)	6 (20 clutches)	7 (10 clutches)
1	1.393 ± 0.222	1.370 ± 0.086	1.416 ± 0.134	1.479 ± 0.129
2	1.417 ± 0.135	1.405 ± 0.074	1.436 ± 0.120	1.482 ± 0.098
3	1.456 ± 0.159	1.431 ± 0.094	1.442 ± 0.125	1.510 ± 0.105
4	1.481 ± 0.173	1.453 ± 0.103	1.452 ± 0.131	1.511 ± 0.102
5		1.498 ± 0.094	1.472 ± 0.129	1.512 ± 0.123
6			1.514 ± 0.124	1.520 ± 0.135
7				1.567 ± 0.151
Total increase first to last egg	0.088	0.128	0.098	0.088
Average increase per egg	0.0293	0.0320	0.0196	0.0147
Per cent average increase per egg	2.04	2.24	1.35	0.97

progressively in both length and breadth, the increase in length is proportionally greater than the increase in breadth.

Weight.—It is clear from Table 6 that in four- and five-egg clutches there is a progressive increase in the weight of eggs from the first to the last laid. In six- and seven-egg clutches the increase from egg to egg is small except for the last egg laid. In the five-, six-, and seven-egg clutches the increase from the penultimate to the last egg is greater than that between any other two eggs, being 3.10, 2.85, and 3.09 per cent of the penultimate egg respectively. In the four-egg clutches, the increase between the second and third is greater than between the last two eggs.

If the four-egg clutches are excluded, the total increase from first to last egg, the average increase per egg, and the per cent average increase all decrease in the larger clutches, which is just the opposite of what occurs with length and breadth.

Two clutches of eggs, not included in the above calculations, contained "runt" eggs. One was the fourth egg of a first clutch for the season, *viz.*, no. 1—1.401 gm., no. 2—1.458 gm., no. 3—1.518 gm., *no. 4—0.800 gm.*, no. 5—1.676 gm., no. 6—1.653 gm. The other was the first egg of a female's second clutch during the season, *viz.*, *no. 1—0.929 gm.*, no. 2—1.250 gm., no. 3—1.258 gm., no.4—1.338 gm., no. 5—1.360 gm. The first egg lacked a yolk, the second egg examined after the rest of the clutch had hatched had a yolk but was apparently infertile.

Analysis of variance for weight.—In order further to analyze the significance and reliability of the differences in egg weights, a three-by-three matrix of figures was composed representing the weights of the first, last, and middle eggs of clutches of five, six, and seven eggs. The "middle" egg of a clutch of six was considered the mean weight of the third and fourth eggs.

The analysis showed that both the position of the egg in its clutch and the clutch-size had a significant effect upon egg weight. The "partition of variability" expressed as percentages came out as follows:

variability as affected by clutch size	39.5 per cent
variability as affected by position in sequence	58.3 per cent
variability as affected by other causes	2.1 per cent
	99.9 per cent

The "coefficients of variation," expressed as percentages, are:

by clutch-size	2.9 per cent
by position in the sequence	3.6 per cent
by other causes	0.7 per cent

Still another analysis of significance by "Student's" *t*-test, has the advantage of incorporating not only the average figures shown in the matrix, but also the standard deviations of these figures, since they are derived from the weighings of many individual eggs, which are pooled to obtain the averages.

The *t*-test shows that in a five-egg clutch the difference between the first and last eggs is significant at the 99 per cent confidence level; in a six-egg clutch it is significant at the 95 per cent level; but in a seven-egg clutch, the difference is *not* significant at the 95 per cent level.

Comparing clutches of different sizes, the *t*-test reports that there is a significant difference, at the 95 per cent level, between the first egg of a clutch of five and of a clutch of seven. The same could *not* be established for the last egg of such clutches.

It is also possible to run various tests of "correlation." For in-

stance, given the weight of the first egg of a clutch, can one prophesy the number of eggs that will be laid or their total weight? There is a positive correlation between these factors, but on account of the considerable scatter in weight of individual eggs, any prophecy is attended with a substantial risk. The coefficient of correlation is approximately +0.33. Curiously enough, when the first two eggs

TABLE 7

CHARACTERISTICS OF PARTICULAR EGGS

	Weight grams	*Length(l) millimeters*	*Breadth(b) millimeters*	*Volume(V) cubic centimeters*	*Specific Gravity*
Female 31917	1.358	16.28	12.49	1.330	1.02
(five-egg clutch)	1.405	16.80	12.57	1.390	1.01
	1.511	16.94	12.93	1.483	1.02
	1.574	17.40	13.04	1.549	1.02
	1.592	17.75	12.99	1.568	1.02
Female 183	1.312	16.55	12.32	1.315	1.00
(five-egg clutch)	1.379	16.61	12.52	1.363	1.01
	1.364	16.53	12.42	1.335	1.02
	1.359	16.51	14.43	1.336	1.02
	1.379	16.66	12.50	1.363	1.01
Female 167	1.440	16.20	12.92	1.416	1.02
(five-egg clutch)	1.395	16.76	12.57	1.387	1.01
	1.391	(egg too cracked to measure)			
	1.398	16.28	12.63	1.360	1.03
	1.430	16.55	12.86	1.433	1.00
Female 26551	1.420	16.02	12.72	1.357	1.05
(six-egg clutch)	1.402	15.87	12.74	1.349	1.04
	1.445	16.24	12.84	1.402	1.03
	1.552	16.29	13.26	1.500	1.03
	1.510	16.43	13.07	1.470	1.03
	1.598	16.30	13.44	1.542	1.04
Female 38479	1.290	16.40	12.10	1.257	1.03
(six-egg clutch)	1.322	16.3C	12.34	1.300	1.02
	1.153[1]	16.65	12.32	1.323	0.87[1]
	1.163[1]	16.68	12.36	1.334	0.87[1]
	1.387	16.78	12.38	1.347	1.03
	1.361	16.99	12.26	1.337	1.02

[1] It appears that the weights and consequently the specific gravities of these two eggs were incorrectly determined.

are taken as a guide and not merely the first one, the correlation drops to about +0.25.

Volume, Mass, Density.—Both dimensions and weights were obtained on 26 eggs, which makes possible the determination of specific gravity when the volume is calculated. If the House Wren egg were a true prolate ellipsoid, its volume could be computed by the equation:

$$V = \frac{\pi}{6} \cdot l \cdot b^2$$

where V is the volume, l the length, and b the *equatorial* diameter.

The coefficient $\pi/6$ is approximately 0.5236. Since the maximum diameter is somewhat closer to the large than the small end, a small modification of this coefficient may be desirable. Actual measurements of volumes are more accurate than volumes calculated from the egg dimensions, but since such measurements are not available, the coefficient given must suffice. Worth (1940) found for eggs of the domestic fowl that volumes obtained by water displacement were 15 per cent less than those calculated by the ellipsoid formula, but the extent of this difference doubtless varies in differently shaped eggs laid by different species or even different individuals.

TABLE 8

DIFFERENCE IN AVERAGE CHARACTERISTICS OF THE FIRST AND LAST EGGS IN THE DIFFERENT SIZED CLUTCHES

	Four-, five-, six-, seven-egg clutches		*Five-, six-, seven-egg clutches only*	
	First egg	*Last egg*	*First egg*	*Last egg*
Average length (mm.)	16.38	16.98	16.47	17.12
Standard deviation	±0.31	±0.23	±0.30	±0.01
Coefficient of variation	1.89	1.35	1.82	0.06
Average breadth (mm.)	12.55	12.89	12.58	12.91
Standard deviation	±0.14	±0.04	±0.15	±0.02
Coefficient of variation	1.12	0.31	1.19	0.15
Average shape index	76.64	75.93	76.36	75.42
Standard deviation	±0.71	±0.88	±0.59	±0.15
Coefficient of variation	0.93	1.16	0.77	0.20
Average weight (gm.)	1.414	1.515	1.422	1.526
Standard deviation	±0.041	±0.032	±0.045	±0.030
Coefficient of variation	2.90	2.11	3.16	1.97
Average volume (cc.)	1.351	1.468	1.365	1.480
Standard deviation	±0.056	±0.025	±0.057	±0.011
Coefficient of variation	4.15	1.70	4.18	0.74
Average specific gravity	1.05	1.03	1.04	1.03
Standard deviation	±0.068	±0.025	±0.078	±0.029
Coefficient of variation	6.48	2.43	7.50	2.82

Volumes of each of the 26 eggs are presented in Table 7 and weight divided by volume gives their density or specific gravity. In all cases, the volume of the last egg is greater than the volume of the first, but otherwise there is considerable irregularity with sequence of laying. There is no consistent trend in specific gravity within the various clutches.

Variability.—There may be physiological importance in knowing which egg in a sequence of laying is most variable in its physical characteristics and which is the most constant. Since the first and last eggs are at opposite extremes of clutch gradients in size and weight, the variability in their average characteristics between clutches of different sizes was analyzed statistically.

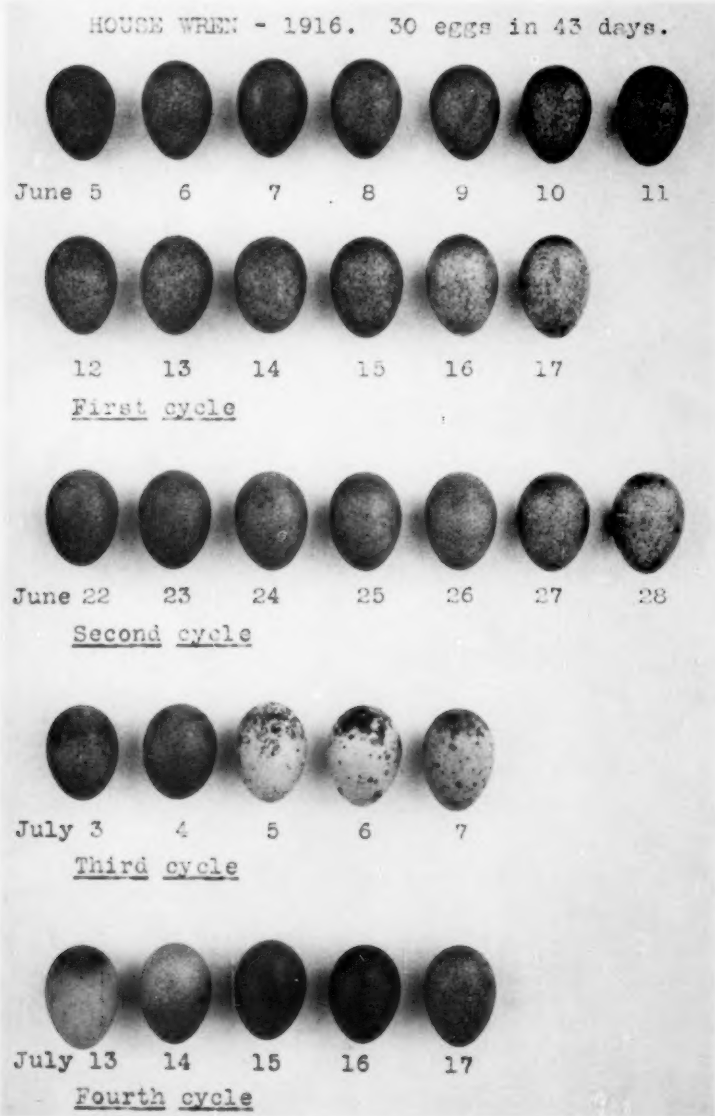
Coefficients of variation compiled in Table 8 are small in most instances, but, except for shape index when the four-egg clutches are included, they are significantly higher for first eggs than for last eggs. Considering the five-, six-, and seven-egg clutches only, the difference in variability between first and last eggs progressively declines for length, breadth, volume, shape index, specific gravity, and weight. The first egg is least variable in its shape index, the last egg in its length. The last eggs in five-, six-, and seven-egg clutches are remarkably uniform in length, weight, volume, and shape index, and while there is a tendency for weight to increase with the size of the clutch, there is less variation in the weight of the last eggs than of the first eggs. This is true also of specific gravity.

Color and markings.—Close observations were taken on the markings of five clutches of five-eggs each, one of a six-egg clutch, and one of a seven-egg clutch. The ground color of wren eggs is white or slightly grayish. The thick covering of markings is reddish brown or rufous or sometimes lavender. The markings are usually heaviest at or near the maximum diameter of the egg, forming a collar. Sometimes the entire large end is thickly pigmented, forming a cap. Rarely, the cap forms at the small end of the egg rather than the large end.

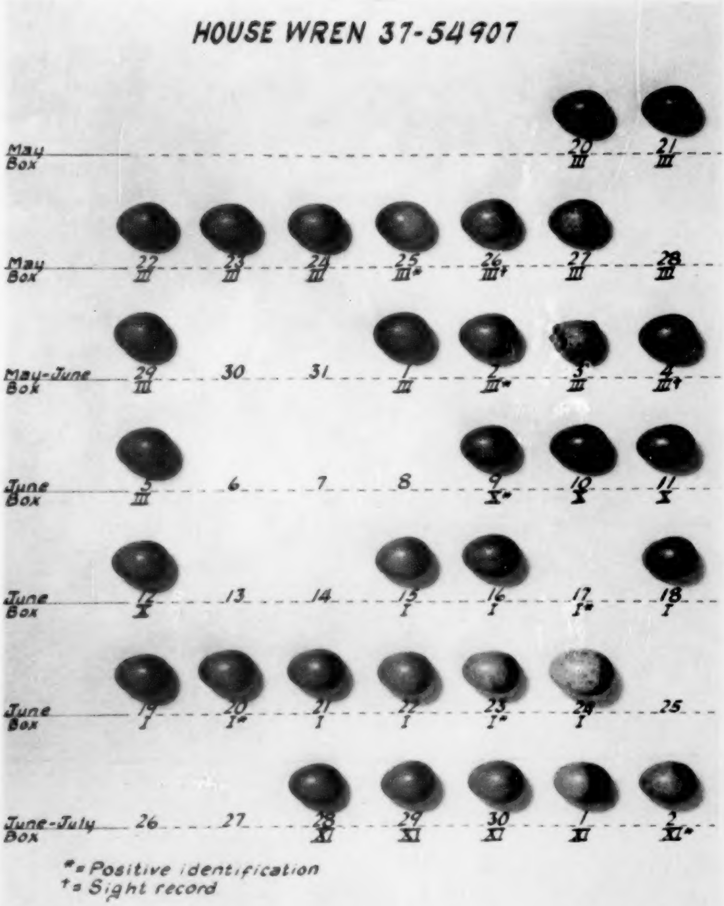
As a rule, the markings in five-egg clutches are fine and uniformly distributed in the first egg becoming progressively coarser and thicker on the subsequent eggs. In the six-egg clutch, the sixth egg had finer markings than the fifth. In the seven-egg clutch the sixth egg also had finer markings than the fifth, but the seventh egg had coarser markings. In this latter set, a day was skipped between the laying of the fifth and sixth eggs. It is also of interest that in this set the markings were reddish brown in the first five eggs but lavender in numbers 6 and 7. With the coarser markings in the later eggs, more ground color shows through so that the fifth egg is usually the lightest. A collar is scarcely perceptible in the first egg, but either a collar or a cap may become conspicuous in later eggs. One set of five eggs was exceptional in that the large irregular markings, together with a collar or cap, occurred on eggs numbers 1 and 5, while egg number 3 had the finest and most uniformly distributed markings.

The markings are seldom straight lines. Sometimes they run lengthwise of the egg although for only a few millimeters, but very often they take a spiral course around the egg. These markings indicate that the egg may make between one-eighth and one-third of a rotation, while a single line of pigment was being deposited. It is uncertain whether the direction of rotation is always the same.

Forced laying.—A preliminary experiment was made by Dr. Leon J.



House Wren eggs laid in the experiment conducted by Dr. L. J. Cole in 1916.



House Wren eggs laid in the experiment conducted by Frances Hamerstrom in 1938.

Cole in 1916 to discover whether the House Wren is a determinate or an indeterminate layer, *i.e.*, whether the number of eggs laid per clutch is controlled by internal physiological factors only or is influenced by external contact with a prescribed number of eggs already laid in the nest (Cole, 1930). The new egg laid each day was removed beginning with the second one laid, so that only one egg remained in the nest from one day to the next. The length and greatest breadth of each egg were measured (Figure 1). The bird began laying on June 5, and the first egg was removed on June 6. She continued to lay one egg each day for 13 days or until June 17. There was then a rest period of 4 days during which the female was occasionally found on the nest and the one "decoy" egg. Seven eggs were laid from June 22 through June 28 with the new one being removed each day.

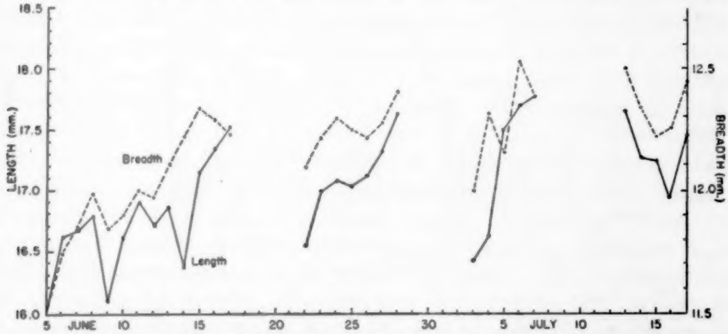


FIGURE 1. Variations in dimensions of eggs in a forced egg-laying experiment conducted by Dr. Leon J. Cole on an unbanded House Wren in 1916.

Another rest period of 4 days followed, after which 5 more eggs were deposited, July 3 through July 7. The rest period this time was 5 days, after which 5 more eggs were laid, July 13 through July 17. She then stopped laying entirely. Altogether she had laid a total of 30 eggs in 43 days.

An examination of the four egg-laying cycles shows that the last two or three eggs were larger than the preceding in three cycles but not in the fourth and last cycle where the first egg was the largest. Furthermore the first eggs of each new cycle, except the fourth, were smaller than the last eggs of the preceding cycle. This is in harmony with our other analyses.

There were also progressive changes in color (Plate 1). The first eggs of the first cycle were dark, but later eggs became gradually lighter. The second cycle began with eggs nearly as dark as the earliest ones of the first clutch and followed a similar color progression.

The third cycle showed greater variability with the first two eggs fairly normal but the last three eggs very different. The small dots became few, so the eggs were very light with large dark splotches. The fourth cycle began with somewhat irregular spotting, but the last three eggs had more normal coloration.

Four years later, Dr. Cole tried the reverse of the foregoing experiment; namely, presenting a full clutch to a wren on the first day of laying. On May 13, the first egg was laid early in the morning, and at 11:00 A.M. six eggs were added to make a total of seven. The following day the second egg was laid, raising the total to eight. Laying continued and on May 28, the nest was getting so full with

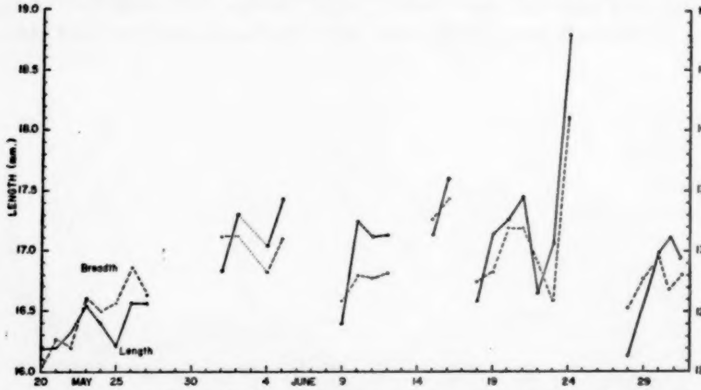


FIGURE 2. Variations in dimensions of eggs in a forced egg-laying experiment with female House Wren 37–54907, conducted by Frances Hamerstrom in 1938.

eleven eggs that three of the dummy eggs were removed and on the following day the other three dummy eggs were taken out. This left six of the birds own eggs. The seventh was laid on May 30 completing a normal set as incubation began. Six eggs hatched on June 11 and 12. The other egg was pipped but did not hatch.

The female wren in Cole's first experiment was not banded, hence it is not certain that the same individual was involved throughout. All evidence indicated, however, that it was. In 1938, Frances Hamerstrom repeated the experiment on several banded individuals in Wisconsin. The repeated trapping and handling of the birds for identification may have disturbed their laying cycle in some instances. Of the 12 experiments attempted, useful results were obtained for 7 females. One female laid 32 eggs in 44 days (Figure 2, Plate 2), other females laid 11 eggs in 13 days, 11 eggs in 15 days, 15 eggs in 30 days, 16 eggs in 25 days, 19 eggs in 29 days, and an unbanded female laid

14 eggs in 17 days. Intervals between successive series of eggs from banded females were: 1 day (2 times), 2 days (3), 3 days (2), 4 days (2), 6 days (1), 9 days (1), and 15 days (1). Normally an entire nesting cycle of four weeks or longer intervenes between laying of two clutches under natural conditions except when the first nest is destroyed, then laying often starts again in a few days.

Including Cole's experiment, 7 of the 8 birds began their first clutch during May or by June 9; the other record is for July and may represent a second clutch. The numbers of eggs laid in these seven first cycles are 13, 9, 9, 8, 8, 7, and 6. The numbers of eggs laid in 7 second cycles are 7, 7, 6, 6, 6, 5, and 5. The July female laid 6 eggs beginning the thirteenth, had a four-day interval, then laid 5 more.

Normal-sized clutches for wrens under natural conditions range from 3 to 9, with 5-, 6-, and 7-egg clutches most common. It appears that attempts to force extra laying resulted only in clutches of normal size after mid-June, but the number of clutches greater than 7 in the first laying cycles is unusual (71 per cent). The average of these seven sets is 8.6 ± 2.22 A compilation of data on all clutches laid under undisturbed natural conditions in northern Ohio during May and before mid-June, 1921 to 1938, gives the following distribution: 4 eggs, 1 clutch; 5 eggs, 7 clutches; 6 eggs, 52 clutches; 7 eggs, 32 clutches; 8 eggs, 4 clutches; and 9 eggs, 2 clutches. Clutches of 8 and 9 eggs constitute only 6 per cent of the total. The average of the 98 clutches is 6.4 ± 0.80. The difference between the two averages is 2.2 and this difference has a standard error of only 0.84 and hence is significant at least at the 95 per cent level. Unfortunately, comparable data for southern Wisconsin are not available.

Cole (1917) considered the House Wren to be an indeterminate layer, and this analysis indicates that the size of clutches laid by House Wrens early in the season is somewhat influenced by the number of eggs previously laid, *i.e.*, the bird shows a tendency toward indeterminism, which is lost after mid-June.

This ability to lay additional eggs has been demonstrated in our observations even when no experiment was intended. One such incident is described by Kendeigh (1952: 24) wherein the first four eggs were removed, probably by a wren itself, the fifth and sixth eggs were laid during the next two days, an interval of three days intervened, and then the seventh, eighth, and ninth eggs were laid. An even more interesting case occurred in 1922, when the first two eggs were laid on June 3 and 4 and the female banded on June 4. On June 5 eggs numbers 1 and 2 were gone but number 3 was present. Seven more eggs were laid on successive days, forming a sequence of eight eggs following the loss of the first two.

Another unusual record was obtained in 1924. The first two eggs were laid on June 12 and 13, but they were gone on June 14. Four more eggs were laid between June 15 and 18. A day was then skipped, and eggs numbers 7 and 8 were laid on June 20 and 21. On the latter day, four of the 6 eggs were then removed by the observer. No change was noted on June 22, but number 9 egg was found on June 23. None of these three records is included in the data averaged above to show number of eggs in normal clutches. There is, of course, an advantage to the species in being able to lay more eggs when part of a set is destroyed as it maintains a normal rate of reproduction.

Clutch size.—A much larger series of data is available for analyzing variations in egg dimensions between clutches of different size than for differences between consecutive eggs within the same clutch, since many clutches were measured where the order of laying the eggs was not known.

An irregular trend is evident (Table 9) for a decrease in average length, breadth, shape index, and calculated volume from four- to

TABLE 9

VARIATION OF EGG CHARACTERISTICS IN CLUTCHES OF DIFFERENT SIZES

	Four-egg clutches		*Five-egg clutches*		*Six-egg clutches*	
	Number	*Average*	*Number*	*Average*	*Number*	*Average*
Length (mm.)	11	16.85	51	16.63	103	16.70
Breadth (mm.)	11	12.95	51	12.79	103	12.76
Shape index		76.85		76.91		76.41
Volume (cc.)		1.480		1.424		1.424
Weight (gm.)	6	1.437 ± 0.022	16	1.431 ± 0.084	20	1.455 ± 0.115
Specific gravity		0.97		1.00		1.02

	Seven-egg clutches		*Eight-egg clutches*	
	Number	*Average*	*Number*	*Average*
Length (mm.)	53	16.55	6	16.55
Breadth (mm.)	53	12.61	6	12.71
Shape index		76.19		76.80
Volume (cc.)		1.378		1.400
Weight (gm.)	10	1.512 ± 0.115		
Specific gravity		1.10		

eight-egg clutches. However, statistical analysis does not give reliability to the differences indicated. It is of interest in this connection that Nice (1937: 114) found that eggs in 49 four-egg clutches of the Song Sparrow averaged 2 per cent longer and 0.6 per cent wider than eggs in 37 five-egg clutches. Using the "Student's" *t*-test, the increase in weight of House Wren eggs from the five-egg to the seven-egg clutches is statistically significant, but the increase from the five-egg to the six-egg clutches is not certainly so.

Special consideration needs to be made of the four-egg clutches.

Kendeigh (1941) stated that "7 eggs per set are common in May and early June, 6 eggs from early June to middle July, 5 eggs from early to late July, and 4 eggs from middle July to August." The laying of larger clutches and heavier eggs was associated with the cool temperatures of May and June and smaller clutches and lighter eggs with higher temperatures in July. In 5 of the 6 four-egg clutches used in analyzing egg weights, the first eggs were laid on July 5, 6, 6, 16, and 17. The odd clutch was laid from May 22 to 25 inclusive. It may be significant that the four days, May 20 to 23, were the warmest consecutive days during the entire month and this may have curtailed the laying of a large set (Kendeigh, 1941). The average weight of the four eggs in this May clutch is greater than the average in four-egg clutches laid normally in July. If this clutch is excluded, the average egg weight in four-egg clutches becomes 1.407 gm. instead of 1.437 gm. (Table 9) and adds to the strength of the conclusion that heavier eggs occur in the larger clutches.

If there is a decrease in the average volume of eggs in the larger clutches, or even if the volume remains the same but there is an increase in the average weight of the eggs, this necessitates a change in their density or specific gravity. Table 7 gives the specific gravity of a few eggs that were both measured and weighed. The average density of 14 eggs in the 3 five-egg clutches is 1.015 ± 0.008. If the two freak eggs are excluded, the average density of 10 eggs in the two six-egg clutches is 1.032 ± 0.009. The difference between these two averages is 0.017 and its probable error $\pm$ 0.004. Although the number of data is small the difference has statistical significance, indicating that the density or specific gravity of the six-egg clutches is greater than that of five-egg clutches.

In Table 9 the measured weights of one sample of eggs when divided by the calculated volumes of a *different* and larger sample of eggs shows an increase in specific gravity as the size of the clutch increases from 4 to 7.

Although an increase in specific gravity is indicated, the actual values for specific gravity given in Table 9 are not trustworthy. The value of 0.97 for the four-egg clutches is certainly too low and the value of 1.10 for the seven-egg clutches may be too high. Probably the excessive range of 0.13 between extreme values results from inaccurate determination of egg volumes, possibly augmented by some change in shape of the eggs in different sized clutches. What is needed is a large series of *direct* determinations of specific gravity. It is obvious, however, that when the specific gravity of an egg is not known, the weight of an egg cannot be accurately calculated from its dimensions or volume as has frequently been attempted.

Age of female.—Since the House Wrens were banded, their age can be approximated. New birds nesting in the area for the first time are considered one-year olds for reasons given elsewhere (Kendeigh and Baldwin, 1937) even though a few birds are known not to nest until they are two years old. After once nesting in the area and being banded, their subsequent careers are accurately followed.

TABLE 10
EFFECT OF AGE OF FEMALE ON SIZE OF EGGS

	1 year old	*2 years old*	*3 years old*
Five-egg clutches			
Number	31	9	7
Length (mm.)	16.59	16.81	16.61
Breadth (mm.)	12.75	12.86	12.85
Six-egg clutches			
Number	54	23	14
Length	16.64	16.65	16.84
Breadth	12.69	12.76	12.95
Seven-egg clutches			
Number	27	13	6
Length	16.44	16.69	16.83
Breadth	12.58	12.62	12.72
Weighted average			
Number	112	45	26
Length	16.58 ± 0.56	16.69 ± 0.63	16.78 ± 0.52
Breadth	12.68 ± 0.36	12.74 ± 0.35	12.88 ± 0.34
Shape index	76.18	76.33	76.76

Table 10 shows that with increasing age, birds lay eggs that are both longer and broader. The increase in length from the first to the third year is 1.21 per cent and in breadth 1.58 per cent. Statistically the differences between eggs of one- and two-year-old females are not significant. The differences in breadth of eggs between two- and three-year-old females and in length of eggs between one- and three-year-old females are significant at the 95 per cent level and the difference between breadth of eggs of one- and three-year-old females is significant at the 99 per cent level. In Song Sparrows (Nice, 1937: 115) the eggs of females two or more years of age average broader than do eggs of one-year-old females, but there is no consistent change in length.

The shape index, calculated from the weighted averages of length and breadth, shows a progressive increase with the age of the female. This means that the eggs increase in breadth to a greater extent than they do in length. This agrees with the data on Song Sparrows (Nice, 1937: 117).

Clutches and individuals.—General trends of variation in average

egg characteristics have been indicated. Can these trends also be detected within single clutches of eggs or in the egg characteristics of the individual birds?

In 36 individual clutches where the sequence of laying is known, the last egg was the longest in 54 per cent of the cases, the second from the last in 8 per cent, the third from the last in 4 per cent, the first egg in 17 per cent, and intermediate eggs, that is, those between the first and the third from the last, in 17 per cent. In respect to maximum breadth, the percentages were: last—50, next to last—21, third from last—3, first—10, and intermediate—17. In 56 clutches, the last egg was the heaviest in 61 per cent, next to the last 7 per cent, third from the last 10 per cent, first 12 per cent, and intermediate 10 per cent. These data show that there is irregularity between clutches but verify the strong tendency for the last egg to be the longest, widest, and heaviest. Nice (1937: 113) found in 17 clutches of the Song Sparrow that the last egg was the heaviest in 41 per cent, the first egg in 29 per cent, an an intermediate egg in 29 per cent.

There are 26 comparisons on 25 females between the average egg characteristics of first and second clutches laid in a single year. In 69 per cent of the comparisons the second clutch was smaller than the first, in 23 per cent it was equal, in 8 per cent it was larger. Likewise in 65 per cent of the comparisons the average length of the eggs in second clutches was less than in first clutches, in 4 per cent it was equal, and in 31 per cent it was greater. In several instances, when the average length of eggs in second clutches decreased, the average breadth increased so that actually in 69 per cent of the second clutches the eggs averaged wider than in the first clutches, in 4 per cent they were equal, and in 27 per cent they were narrower. Thus, since there is a strong tendency for a decrease in length to be compensated for by an increase in width, a comparison of calculated volumes shows that in 58 per cent, the average volume of eggs in second clutches was greater, in 38 per cent it was smaller, and in 4 per cent it was equal. It is doubtful, therefore, if there is any significant difference in volume between eggs in first and second clutches.

In 17 comparisons of two clutches laid by the same Song Sparrow in the same year (Nice, 1937: 115), the dimensions of the egg decreased in 12 per cent of the cases, were the same in 6 per cent, and increased in 82 per cent. The eggs in the later clutches averaged 0.8 per cent longer and 2.5 per cent broader than the eggs in the early clutches. This shows a different relation from that in the House Wren.

The increase in average egg dimensions with aging of female House

Wrens is not supported by 14 comparisons of data obtained on eggs of birds one and two years old and 3 comparisons with birds three years old. In fact, in 11 of the 17 comparisons, the eggs are smaller in the older birds. The number of data available for individual birds is small, however, compared with the analysis presented in Table 10.

Records are available on 37 females where two to four clutches of eggs laid by the same individual either during the same year or in subsequent years were measured. These records make it possible to compare the amount of variation among eggs laid by the same female at different times and by different females. Since there is variation among individual eggs within a clutch, correlated with sequence of laying, comparisons are here made only between the average dimensions of whole clutches. The extreme range in average length and breadth measurements of eggs laid by different females is from 15.61 × 12.51 mm. to 18.09 × 13.20 mm. These ranges in length of 2.48 mm. and in breadth of 0.69 mm. are 14.9 and 5.4 per cent respectively of the mean dimensions of all the eggs. Nice (1937: 112) found in an analysis of 503 eggs of the Song Sparrow that the extreme range in length in percentage of the median was also greater than the extreme range in width. The *greatest* variations in average length and breadth of different clutches of one female House Wren were 4.0 and 4.5 per cent, respectively. The *average* extreme differences between different clutches laid by the same female are for length, 0.28 mm. and, for breadth, 0.21 mm., which are 1.7 and 1.6 per cent respectively of their average dimensions. Individual females, therefore, tend to lay eggs in different clutches of nearly the same average dimensions. The variability among different clutches of the same female is much less than among different females in the species.

Physiological interpretations.—The above primarily statistical treatment indicates that within a House Wren clutch, the last two eggs increase both in maximum breadth and length, but proportionately more in length than breadth. There is also an increase in weight and in coarseness of color markings in the egg sequence. The last eggs of clutches of different size are more alike in dimensions, shape, volume, weight, and specific gravity than are the first eggs. The bird can adjust for loss of eggs during the first laying cycle of the season by laying an average of two additional eggs, but this is not true in later cycles. Do these facts shed any light on the mechanism of egg formation?

Detailed information on the formation of eggs within the body of the bird is available only on the domestic fowl, and this informa-

tion is by no means as complete as desired. The germ cell, yolk, and vitelline membrane are laid down in the ovary; all other parts of the egg are formed in the oviduct. There are several hundred ova in the ovary, but only a few mature, progressively one at a time. The ova, enclosed in individual follicles, initially consist largely of protoplasm and contain relatively high proportions of water and protein. Fats (phospholipids) are deposited from the blood as the ovum matures, and the percentage of water decreases. The increase in the size of the ovum is slow at first in all species studied but becomes very rapid two to eight days prior to ovulation.

The seasonal development of the ovary and ova is under control of follicle-stimulating and luteinizing hormones secreted by the anterior pituitary. The rapidly growing follicles and ova produce another hormone, estrin, which in turn stimulates the growth of the oviduct. Estrin is also responsible for increasing the mobilization of food substances needed for the formation of the egg and transported by the blood. As the laying of the clutch progresses, increasing amounts of prolactin are released from the pituitary gland, that decrease the production of gonad-stimulating hormones, bring about cessation in the development of ova, and induce incubating behavior (Riddle, 1938; Romanoff and Romanoff, 1949).

The chief regions of the oviduct are the infundibulum or funnel which receives the ovum when it erupts from the ovarian follicle (ovulation) and where fertilization occurs, the pars magnum where the chalazae and albumen are secreted around the yolk, the isthmus that secretes the two shell membranes, the uterus where the shell is formed and pigment is deposited, and the vagina which is involved only as a passageway when the egg is laid. The walls of the oviduct contain an outer longitudinal and an inner circular muscular layer. The outer layer controls the length of the oviduct, the inner layer controls its diameter, and coordination of muscular action in the two layers produces peristalsis that moves the egg mass onward through the oviduct. Ciliary action of the oviduct lining is probably also involved. The inner mucous membrane and ciliated epithelium are thrown into folds and contain many secretory glands. These glands are stimulated to secrete when exposed to contact pressure from the ovum and associated egg mass.

In the domestic fowl, the ovum enters the oviduct about 15 minutes after ovulation, passes through the infundibulum in 18 minutes, spends 3 hours in traversing the pars magnum, 1 hour in the isthmus, and the remainder of the time, usually 20 to 24 hours, in the uterus (Warren and Scott, 1935). Ovulation usually follows the laying

of the previous egg within about 30 minutes, except when the previous egg is laid late in the afternoon, in which case ovulation is delayed until early the following morning. The interval between laying of successive eggs is usually greater than 24 hours, so that they are laid at progressively later hours until a day is skipped, after which egg-laying begins again in the early morning. Each series of eggs (usually 2 to 18) is called a clutch. The time interval between successive eggs in most song birds appears to be 24 hours, and much longer intervals of days separate successive clutches.

There is considerable uncertainty as to how the exact shape of the egg is determined (Pearl, 1909; Curtis, 1914: 322; Asmundson, 1931; Conrad and Scott, 1938; Harper and Marble, 1945), but there is general agreement that the shape is established by the time the egg leaves the isthmus. Factors involved are doubtless the size of the egg mass, the diameter of the pars magnum and isthmus, and the relative tension or action of the circular and longitudinal muscle layers in the walls of the oviduct. The small end of the egg is always directed caudalward in all parts of the oviduct anterior to the uterus, but in the uterus the egg is often rotated so that a large percentage are laid large end first.

It has been shown in two extensive studies of the domestic fowl that, outside of the shell, the weight of the yolk is the most variable characteristic of the egg (coefficient of variation: 11.31 ± 0.11, Curtis, 1914; 13.11 ± 0.24, Asmundson, 1931). A large yolk stimulates a greater production of albumen and shell and there results a good correlation between the weight of the yolk and the total weight of the egg ($+ 0.538 \pm 0.018$, Asmundson, 1931). The circular muscles in the walls of the oviduct would exert a greater pressure on a large than on a small egg mass and allow less albumen to remain around the equatorial region of the yolk. There is much less pressure restricting the lengthwise extension of the egg mass, and this may explain why large wren eggs in a clutch are proportionately longer than small eggs.

Each fine color mark is presumably produced by pigment deposition from a single gland in the uterus. With the smaller first eggs of the clutch this pigment is deposited evenly and uniformly, but with the larger later eggs in the clutch there may be exhaustion of pigment from many glands and, because of greater pressure against the walls the pigment, which is secreted is massed into coarser lines or splotches. Greater pressure from the large end may be responsible for the formation of a collar or a cap. The rotation of the egg in preparation for laying may account for the observed spiral direction of the markings.

Successive eggs in clutches of the domestic fowl, contrary to those in the House Wren, decrease in size and weight (Atwood and Weakly, 1917; Bennion and Warren, 1933). In two-egg clutches, the total decrease amounts to 2.2 per cent and in eight-egg clutches, 3.5 per cent. However, there is a decrease in per cent loss per egg in clutches of increasing size; in two-egg clutches this decrease is 2.2 per cent, in eight-egg clutches only 0.4 per cent. The decrease in weight has been explained as resulting from exhaustion of material available for elaborating into the various egg parts or to a fatigue of the organs involved so that less material is secreted. It may be significant that the greater the productive capacity of a hen, the larger are the clutches produced and the smaller is the average decrease in the weight of the eggs which are laid on consecutive days. Hormones may also be involved. Increased thyroid activity will induce a decrease in the size of the egg and in the amount of yolk produced (Asmundson, 1931a), and it is conceivable that variation in the action of estrin and prolactin may produce effects.

The increase in size and weight of consecutive eggs in the House Wren is more nearly comparable to what happens in mature domestic fowl after pauses in egg laying. Here it has been shown that the first eggs produced after pauses of 8 to 30 days were lighter in weight than the last eggs before the pause, but normal weight of the eggs was obtained with the laying of the second or third egg (Bennion and Warren, 1933). The egg weight of pullets also increases during the first three or four months of production (Jull, 1925). This may be correlated with the increase in size of the pullets and presumably with increasing ability to assimilate and mobilize various food elements, especially protein, necessary for egg production (Jull, 1924).

The fact that the first egg of clutches of different size in the House Wren are more variable in dimensions and weight than the last egg suggests that there may be a standard efficiency or procedure in egg formation which is not attained with the first egg but more closely as additional eggs are produced. Pearl (1909) cites a case in the domestic fowl where the first egg of a pullet was very abnormal in shape, but succeeding eggs changed progressively back to normal. Increased proficiency in mobilizing energy and in the mechanics of egg formation may also account for the larger eggs laid by the older birds.

There is a certain amount of irregular variation in the characteristics of the early eggs laid in the clutches of different size, but a consistent and marked increase in length, breadth, and weight from the third to the second from the last to the last egg. This is of special interest since it is correlated with an increase of incubating behavior with

the third egg in five-egg clutches and the fourth egg in six-egg clutches (Kendeigh, 1952: 20). Environmental conditions, especially temperature during the two or three days preceding the laying of the eggs, have been shown to affect the weight and the number of eggs laid in the clutch (Kendeigh, 1941). It would appear that changes of some sort are being set into action at this stage in egg-laying that anticipate the normal termination of the clutch within an interval of two more days. The present study gives no hint of what these factors may be, although the hypothesis suggested by Kendeigh (1952: 24), that one or more hormones from the pituitary, particularly prolactin, may be associated with the changes, still appears likely.

If the size of the clutch is determined on the second day preceding the laying of the last egg, any other follicles or ova that had started to develop would stop or might even begin to atrophy. This might then explain the increase in size of the last two eggs in the clutch. Yolk material being brought to the ovary by the blood would not be divided among all the maturing ova but would be concentrated into the remaining two ova of the clutch and on the last day into the final ovum alone. It appears that the most rapid and critical growth period that affects the eventual size of the complete egg comes during the two or three days prior to its being laid.

The increase in the weight of eggs in the larger clutches without an increase in volume is obviously correlated with an increase in specific gravity, but why the specific gravity should increase so markedly in the larger sets is not immediately obvious. The differences in specific gravity among different eggs in the House Wren are much larger than have been noted in the eggs of the domestic fowl, turkey, and duck where extreme limits are 1.056 and 1.116 and the most common range is 1.080 to 1.090 (Romanoff and Romanoff, 1949: 368).

It has also been established for the domestic fowl that the proportion of shell to the total weight of the egg remains the same in eggs of different sizes (Romanoff and Romanoff, 1949: 116). It appears, therefore, that the greater specific gravity of eggs in the larger clutches of the House Wren may result from a greater proportion of solids to water in the egg contents. This can only be determined by direct measurements.

Romanoff and Romanoff (1949: 323) have compiled data for 14 species of altricial birds, which indicate that the average water content of the eggs is 80.9 per cent. Although there is not a great deal of difference in the absolute amounts of solid matter in yolk and albumen, the albumen contains between five and six times more water than

does the yolk. House Wrens feed almost entirely on insects and derive water from their body fluids and from oxidation of nutrients which they provide. They seldom drink water directly, but it is hardly conceivable that lack of water is a critical factor in regulating the specific gravity of the egg contents. The likelihood is much greater that the density of yolk and albumen depends on the amount of solid materials that are available.

TABLE 11

COMPOSITION AND ENERGY VALUE OF SOLID SUBSTANCES IN THE YOLK AND ALBUMEN OF AN AVERAGE SIZE (1.500 GM.) HOUSE WREN EGG, CALCULATED FROM DATA GIVEN FOR OTHER SPECIES BY ROMANOFF AND ROMANOFF (1949)

	Yolk solids		*Albumen solids*		*Total solids (exclusive of shell and membranes)*	
	Amount in grams	*Energy value in Calories*	*Amount in grams*	*Energy value in Calories*	*Amount in grams*	*Energy value in Calories*
Proteins	0.048	0.211	0.099	0.436	0.147	0.647
Fats (lipids)	0.093	0.879	0.000	0.000	0.093	0.879
Carbohydrates	0.003	0.013	0.008	0.034	0.011	0.046
Inorganic	0.003	—	0.006	—	0.009	—
Total	0.147	1.103	0.113	0.470	0.260	1.572

Aside from their water content, yolk is composed mostly of fats and albumen mostly of proteins (Table 11). If the energy value of proteins is taken as 4.40, carbohydrates as 4.20, and fats as 9.45 Cal. per gram, the total energy, except for that in the shell membranes, of an average-sized House Wren egg is calculated as 1.572 Cal. This is equivalent to 105 Cal. per 100 grams or reasonably close to the value of 116 given for the egg of the House Sparrow (*Passer domesticus*) (Tangl, 1903). This energy must be obtained from the food eaten and from body reserves in the female. Furthermore most of it is probably deposited in the various parts of the egg in the period beginning three days before the first egg is laid and lasting until the last egg is fully formed. Thus most of the energy in a six-egg clutch is acquired in about a nine-day period or at an average rate of about 1.048 Cal. per day.

The daily energy intake and requirements of the House Wren have not been measured, but using comparable data obtained during the summer months for the House Sparrow (Davis, 1955) and considering that the female House Wren weighs 11.5 grams, the average energy demands for existence would be at least 8.8 Cal. per day, and the bird would be potentially able to absorb an additional 3.2 Cal. per day for productive purposes. The amount required for egg production

would take about one-third of this potential surplus. However, any variation in this energy balance, either in intake or outgo, would conceivably affect the amount of material available for egg formation and thereby modify its specific gravity, size, and other characteristics. It is well known that the start of egg-laying in altricial species is often delayed by cold rainy weather in the spring, and this doubtlessly results from an increase in energy demands for existence with the consequent decrease in the amount of surplus energy available for other purposes.

When the bird first returns at the beginning of the breeding season it is at a peak of activity and vigor. The cool weather stimulates maximum feeding and a high level of productive energy. A high energy balance permits not only heavier eggs but more of them per clutch. As the season progresses and brings higher temperatures, there is a decrease in the rate of feeding and the lighter eggs and smaller number per clutch may well be a result of a less favorable energy balance.

Summary and conclusions.—1. The last two eggs laid in clutches of the House Wren are longer and broader, have a greater calculated volume, and are heavier than the first ones laid. The increase in length is proportionately greater than the increase in breadth.

2. The physical characteristics of the first egg in clutches of different size are more variable than of the last egg in the clutches.

3. The first eggs of a clutch tend to be darker in color because the markings are finer and more evenly distributed.

4. During its first laying cycle of the season, the House Wren shows a tendency toward indeterminism in that it may lay an average of two additional eggs if early eggs in the clutch are lost. Later in the season this indeterminism is lost.

5. There are no certainly significant differences in average length, breadth, shape, or calculated volumes between eggs in different size clutches, but larger clutches contain heavier eggs.

6. A greater specific gravity for eggs in large clutches compared with small clutches is indicated, but more positive evidence is required to establish the point.

7. Birds in their first reproductive season tend to lay smaller eggs than older birds, but this is not true of all individuals.

8. There is less variation among different eggs laid by the same bird than among the average egg characteristics of different birds.

9. The hypothesis is developed that the physical characteristics of the egg are influenced in an important manner by the energy resources of the bird during the three days immediately preceding laying.

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THE RECENT REAPPEARANCE OF THE DICKCISSEL (*SPIZA AMERICANA*) IN EASTERN NORTH AMERICA

BY ALFRED O. GROSS

THE DICKCISSEL is very erratic in its distribution, and its numbers in certain localities, even in the center of its nesting range in the Middle West, fluctuate greatly from year to year. A certain locality may have an abundance of Dickcissels only to have them practically disappear after a few years. Sometimes this fluctuation extends over a large area of one or more states so that we may speak of a "high" or "low" year for the Dickcissel (Taber, 1947).

The most remarkable feature of this erratic bird's distribution has been its recession and now its recent extension of its range to the eastern part of North America. It is well known that during the nineteenth century it nested and was a common species in a wide range extending from the Carolinas through Pennsylvania, New Jersey, and New York to Rhode Island and Massachusetts. Stragglers were collected as far south as Florida and as far north as New Hampshire and Nova Scotia (Gross, 1921). By the end of the century it had practically disappeared from the vast area east of the Allegheny Mountains. One may find many accounts of its diminution in numbers, and predictions were freely made that the Dickcissel was destined to be completely extirpated from this part of its former range (Rhoads, 1903).

It nested in Mississippi as late as 1900 (Stockard, 1905), and the last record of its nesting in the more northern section of this area was a nest found at Plainfield, New Jersey, on July 3, 1904 (Miller, 1904). The mystery of its disappearance has never been satisfactorily explained. Just as baffling is its recent reappearance in great numbers to the region it deserted fifty years ago. After 1920 stragglers again appeared in the east, and a pair nested in Georgia in 1923 (Burleigh, 1927); but the year 1928 marks the date when the Dickcissel gave the greatest promise of a general return. In that year, there were records ranging all the way from localities in Florida, the Carolinas, Pennsylvania, Maryland, and New Jersey to the Bay of Fundy. They are arranged chronologically as follows: April 11, Pensacola, Florida (Howell, 1932); April 26, Tallahassee, Florida, 1 male (Williams, 1929); May 18, Columbia, South Carolina, 1 bird (Smyth, 1930); May 19, Raleigh, North Carolina, 1 pair (Snyder and Brimley, 1928); May 25, Columbia, South Carolina, colony of fifty birds (Smyth, 1930); May 26, June 9 and 18, Darling, Penn-

sylvania, 1 male, 1 male, 1 pair (Stone, 1928a); June 5, S. C.-N. C. state line on route No. 1, 1 bird (Smyth, 1930); June 10 and 11, Sharptown, New Jersey, 1 male (Stone, 1928b); July 15 and 22, Dickerson, Maryland, 6 males, female feeding young (Wetmore and Lincoln, 1928); August 6, Hendersonville, North Carolina, 2 males singing (Pearson, Brimley, and Brimley, 1942); September 23, aboard a steamer, in the Bay of Fundy, New Brunswick, male in winter plumage (Rand, 1929); November 5, aboard a ship 140 miles off Cape Charles, Virginia, 1 female (Holt, 1932). These many records in 1928 struck an optimistic note, and observers had every reason to believe the Dickcissel was staging a substantial comeback in the East. The numbers of Dickcissels fluctuated during the next fifteen years but with no notable increase in this period over the numbers reported for 1928.

It is difficult to ascertain the relative abundance of Dickcissels from year to year when based on individual reports. However, the detailed records of numbers in "New England Bird Life," 1936–1944 published by the New England Museum of Natural History, and its successor, "Records of New England Birds" published by the Massachusetts Audubon Society, 1945 to the present, are at least helpful in hinting of the status of the Dickcissel in New England from year to year. The number of individuals reported each year by these two publications are as follows: 1937, 1; 1938, 3; 1939, 1; 1940, 6; 1941, 1; 1942, 0; 1943, 3; 1944, 0; 1945, 4; 1946, 18; 1947, 9; 1948, 19; 1949, 50; 1950, 51; 1951, 72; 1952, 122; 1953, 288. This represents a total of 647 Dickcissels in 398 separate reports in the New England states alone. It will be seen that from 1948 on, the increase was extraordinary, with 288 reported in 1953. The 647 were distributed by states as follows: Maine, 53; New Hampshire, 6; Vermont, 6; Massachusetts, 489; Rhode Island, 44; and Connecticut, 49. The extremely large number reported from Massachusetts is due in part to the larger number of active field observers in that state, but even so, it is obvious that the density of the present influx of Dickcissels to New England is centered in the state of Massachusetts.

If we arrange the 647 New England records according to the months of the year we have the following: January, 77; February, 44; March, 25; April, 28; May, 4; June, 0; July, 0; August, 34; September, 128; October, 114; November, 88; December, 105. According to this tabulation, the Dickcissels make their appearance in New England during the month of August, reach their maximum during September and October, and later drop off until May. None were reported for the months of June and July, although there are a few summer

New England records not included in "Records of New England Birds" (Packard, 1952). Most of the reports tabulated above are for one or two birds, rarely as many as 3 to 5, the average being 1.6 birds to a report. Many of these winter records are of individuals that visit feeding stations. Often the Dickcissels are associated with English Sparrows; the latter belong to a different family and are radically different, especially in their nesting habits. At the feeding stations these two birds somewhat similar in size and appearance have common feeding habits that bring them together. The observations made at the feeding stations have greatly augmented the number of records. In fact, feeding stations may be a factor in the great numbers that appear in New England during the winter months.

In going through the "Audubon Field Notes," the general statements found in the regional reports indicate that the bulk of the Dickcissels that come to the East in the fall appear in the Middle Atlantic states, New England, and the coastal region of Canada. (For Canada see also Godfrey, 1954.) This distribution suggests that the Dickcissels of the northeast come directly in a west-east migration, probably aided by the prevailing winds at that time of the year, from the breeding grounds in the Middle West and travel in a path north of the barrier of the higher Appalachian Mountains. They continue on eastward until finally stopped by the barrier of the Atlantic Ocean, the bulk of them reaching it on the Massachusetts coast and from there fanning out northward to Maine and Canada. Some also may move southward from Massachusetts. This assumption seems reasonable when we consider that the great majority of the records are from the coastal area of New England, and Dickcissels have even been found on islands such as Block Island, New York; Nantucket, Martha's Vineyard, West and Plum islands, Massachusetts; Monhegan and other islands in Maine; and Machias Seal Island, New Brunswick. Furthermore, some continue on and have taken refuge on boats at sea (Fleisher, 1926; Holt, 1932; Libby, 1954; and Rand, 1929). Scholander (1955) reports a Dickcissel landed October 8, 1937, on a ship at 36° 16′ N., 67° 52′ W., which is approximately 375 miles from land, and no doubt some of the more adventurous birds are lost at sea.

In the spring, I believe the bulk of the Dickcissels that spend the winter in the northeast return directly to the great nesting area in the Middle West by a direct east-west migration over the route previously mentioned. There are an increasing number of records in the area between the east and west to suggest this route, but many banding records are sorely needed to establish the truth of this as-

sumption. This west-east and east-west migration has a parallel in the case of several other species, for example in the Evening Grosbeak in which it has been gradually developed but now is a fixed practice. The Evening Grosbeak now nests in the northeastern section of the United States and southeastern Canada, and it might reasonably be expected that in the future the Dickcissel will again be nesting in New England. However, it is not safe to predict what will be the future status of a bird like the Dickcissel that has proven so erratic in its numbers and distribution.

As yet I know of no recent authentic nesting of the Dickcissel in New England and eastern Canada. All of the eastern nesting records thus far have been from the more southern states. John W. Aldrich's map of the breeding distribution of the Dickcissel, taken from U. S. Fish and Wildlife species distribution maps and from the Service's species distribution card file, show the following approximate number of localities in the states east of the Mississippi and Ohio rivers: Mississippi, 1; Alabama, 6; Georgia, 2; Tennessee, 2; Kentucky, 1; West Virginia, 2; Virginia, 2; Pennsylvania, 2; and New Jersey, 1 (Aldrich, 1948). The dates and the names of the places where the Dickcissels are breeding are not given. There have been a large number of recent nesting records, chiefly in the Gulf and southern Atlantic states since Aldrich's map was published in 1948.

I am inclined to believe that the Dickcissels nesting in our southern states reach there from the south in the spring rather than coming directly from the west in the fall over the route suggested for our northern winter visitors. During the spring migration from northern South and Central America, it is conceivable that some of the birds on reaching the mid-southern United States are diverted to the eastern part of the United States instead of following the Mississippi Valley route to the main nesting area. Some of the birds may arrive by the Trans-Gulf Route (Lowery, 1946). Many of the dates of arrival in our southeastern states correspond to the dates of the spring arrivals in the lower Mississippi Valley.

Regardless of how the northern and southern contigents of Dickcissels arrive, the sudden change in the status of this bird in the eastern part of the United States is extraordinary. A remarkable feature of their change in behavior is the tendency for an increasing number to migrate east for the winter instead of following the traditional migration to their winter quarters in the south. This whole matter deserves close attention and further study.

It is also interesting to note that there is a recent tendency for the

Dickcissel to extend its nesting range to the north and west from the Middle West and for a greater number to nest in the southern part of the mid-western area.

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11 Boody Street, Brunswick, Maine, December 10, 1954.

IS THE GREAT WHITE HERON A GOOD SPECIES?

BY ERNST MAYR

THE heron family contains many interesting and puzzling cases of aberrant plumages. Examples from the North American herons are the Reddish Egret (*Dichromanassa rufescens*), with a normal and a white plumage, and the Little Blue Heron (*Florida caerulea*), with an immature white and an adult blue plumage. During my travels in the South Seas I saw almost daily individuals of the Reef Heron (*Egretta sacra*) which has a white color phase in addition to a normal gray one. When I first heard of the Great White Heron (*Ardea occidentalis*), I was certain that this so-called species was nothing but a locally distributed color phase of the Great Blue Heron (*Ardea herodias*), but then I became uncertain. It is museum workers like Ridgway and me who are inclined to consider the Great White Heron as conspecific with the Great Blue, while many of the naturalists who have studied them in the field considered these two forms good species. Holt (1928) presented the evidence in favor of the specific distinction of the Great White Heron so convincingly that his thesis was adopted in the Check-List of the American Ornithologists' Union and by the great majority of subsequent writers.

Yet, much as has been written about the Great White Heron, it has never been studied from a modern point of view. The new systematics, for which the population is the basic unit, always asks two questions when comparing two similar morphological types:

(1) Are individuals of these types merely divergent members of a single population, or are there in fact two? In the present case: Are the Great White Herons merely albino individuals of the Great Blue Heron, or do they form a separate population?

(2) If it is a separate population, is it reproductively isolated? If this question is answered with yes, the population is considered a good species. It is a subspecies, however, if it freely interbreeds with other populations.

First Question. What is the evidence for the alternative "albino individuals versus a discrete population"? Holt (1928) cites a number of points, which he considers as proof of the "population" character of the Great White Heron:

(1) Whiteness. "It is a pure white bird." This, of course, does not prove specific distinctness, because it is equally true for the white color of such unquestioned color phases as that of the Reddish Egret and Reef Heron.

(2) Bill. "The Great White Heron has a relatively larger bill than Ward's Heron." To determine the validity of this statement I have determined the bill index (length of the bill in per cent of wing length) in eleven adults of *occidentalis* and in fifteen adults of *Ardea herodias wardi*. This index is as follows:

occidentalis: 28.7, 29.1, 29.6, 31.0, 31.1, 31.5, 31.8, 33.0, 33.1, 33.9, 35.2. Mean: 31.6.

wardi: 27.5, 28.3, 28.7, 28.7, 28.9, 28.9, 29.4, 29.7, 29.8, 30.5, 30.5, 30.9, 31.1, 32.3. Mean: 29.7.

These figures show that of the 26 measured birds 20 are in the zone of overlap. Two *wardi* have a shorter bill than any *occidentalis*, and four of the latter a relatively longer bill than any *wardi*. There is thus an average difference in the relative length of the bill, but much overlap.

(3) Plumes. "The occipital plumes of *occidentalis* are reduced or absent." There can be no argument about this fact, only about its interpretation. Other cases are known, where albinos differ in feather structure from wild color birds. Yet, the evidence in the present case is rather overwhelming in favor of the assumption that the shortness of the occipital plumes is a population character of the Key West birds as compared to Florida mainland birds, rather than a by-product of whiteness in white individuals.

Our first question then can be answered with fair assurance: The Great White Herons are not merely albino specimens of Ward's Heron, but form a mangrove population in the Key West area which differs from Ward's Heron on the mainland not only by the white coloration, but also by shorter plumes and an average larger bill. This agrees with the findings of Holt and other recent investigators.

Second Question. What is the taxonomic status of this population? Is it a good species or is it an island subspecies of the Great Blue Heron?

Holt came to the conclusion that it was a good species and this conclusion has been accepted by the A.O.U. Check-List Committee. The arguments cited in favor of this decision are three:

(1) There is a behavior difference between the two kinds of herons. "The Great White Heron is a much shyer bird than the Great Blue." This observation of the older authors is not confirmed by more recent investigators. Sprunt, Robert Allen, Dan Beard, and others have written me that the shyness of these herons is directly proportional to the amount of persecution they suffer. Formerly, the Great White Herons were exposed to the unmerciful depredations of the Key West sponge fishermen. Since their protection they have

become much less shy. Whether or not shyness is always an "acquired" characteristic of a population or at least in part innate, is still disputed.

(2) They differ in their ecology. "The Great White Heron is a maritime species. The Great Blue is a fresh water bird." Again the assertion is not correct. To be sure, the Great White Heron is undoubtedly a salt water population. However, there are also many salt water populations of the Great Blue Heron, particularly along the coasts of the Gulf of Mexico, all the way from Florida to Mexico, and perhaps in the West Indies.

(3) "The two species nest side by side in Florida Bay and on the Key West Islands." This is the most difficult statement either to prove or to disprove. Additional facts need to be collected. Yet, there is already a great deal of evidence available that is highly suggestive:

(a) Many pairs have been found of which one parent was white, the other blue; among the young in many nests there have been both white and blue birds.

(b) An intermediate plumage type is known, the so-called "Würdemann's Heron." These intermediates are extremely variable. Some are entirely white-headed and otherwise very pale. Others appear indistinguishable from the Great Blue Heron except for having the occipital plumes shorter and with more white. It would be impossible to distinguish such birds in the field from Ward's Herons.

(c) All presumed "Ward's Herons" collected by Holt on the islands of Florida Bay turned out to be Würdemann's Herons when subsequently carefully examined in the museum (Holt, 1928).

(d) The only "Ward's Heron" from the Keys, examined by me, turned out to be a winter visiting Great Blue Heron from the north. In fact, I do not know of the existence in any museum of a single breeding specimen of pure Ward's Heron from the Florida Keys. However, so many so-called Ward's Herons have been observed in Florida Bay that their presence there can hardly be disputed.

(e) Dimorphic populations of the Great Blue Heron are known from the West Indies (Cuba, Isle of Pines, Jamaica) and Yucatan. In fact, an occasional white or *würdemanni*-like bird may occur anywhere within the range of the Great Blue Heron (see local records in several of the states north and west of Florida, often recorded as Great White Herons, rather than as albinos).

The cumulative weight of these five points of evidence is very strongly in favor of accepting *occidentalis* as a dimorphic subspecies of the Great Blue Heron, localized in the Florida Keys.

The History of the Great White Heron

In view of wide distribution of the Great Blue Heron on the mainland of America, without conspicuous geographic variation, it would seem legitimate to ask, how the very distinct dimorphic race of the Florida Keys evolved. Evidently this leads into the realm of speculation. We know that other dimorphic populations of this species (of smaller body size) occur on some of the Greater Antilles, although, here, the percentage of white birds in the population is comparatively small. There is little doubt that *occidentalis* is derived from such a dimorphic West Indian population. What we do not know, and probably never will, is whether the founders of the Florida Key population were, by chance, white and thus gave rise to a prevailingly white population or whether the white gene had a superior survival value on its genetic background in the ecologically distinctive environment of the Florida Keys. The "isolation effect" (Mayr, 1954) might have played a role in this change. Regardless of the reasons, the fact remains that in the Key area an endemic population developed consisting predominantly of white birds. This population appears to have been at one time quite effectively isolated from mainland birds, possibly because of some of the Pleistocene changes of climate and sea level. During this isolation genetic changes occurred which now find their visible expression in an enlargement of the bill, a reduction of the occipital plumes, and (as we shall presently see) in the acquisition of genes modifying the blue plumage from the Great Blue type in the direction of the Würdemann type.

In due time the isolation broke down and the Key population came again in contact with the mainland population of the Great Blue Heron (*wardi*). This occurred particularly on the inner Keys and on the islands of Florida Bay. There seems to be an increasing infiltration of genes from the mainland onto the islands of Florida Bay. It is here that observers most often see birds that seem to be *wardi*. R. P. Allen tells me that according to his recollection, on the outer Keys, where the gene infiltration from the mainland is not so pronounced, Würdemann's Herons tend to be more often of the extreme type (white head, very pale) than on the inner Keys of Florida Bay.

Here we are up against an as yet unsolved problem. The great variability of so-called Würdemann's Heron and the field observations of mixed white-blue pairs show clearly that *occidentalis* mixes with "*wardi*." However, what we do not know yet is the answer to this simple question: Do *occidentalis* and mainland birds hybridize in

this zone only occasionally or do they interbreed at random in their zone of contact?

This question, which corresponds closely to the Snow Goose—Blue Goose problem, can be solved only by field observation. Quantitative studies must be made on islands in the contact zone, that will show whether the frequency of mixed pairs corresponds to that expected by chance or is lower. Some casual observations by correspondents of mine suggest that possibly there is a tendency among blue birds to mate with blue birds, and of white to mate with white. But to say anything further would be pure speculation. The time has come for solid field work. The problems that need to be solved are the following:

(1) Study of variability of *würdemanni* on the Keys. Apparently they vary from almost *wardi*-like birds (with shortened plumes) to "extreme" *würdemanni* with much white in the plumage.

(2) The ratio of blue to white birds should be determined on some of the Keys, particularly inner and outer Keys. These censuses are most important. Is there a clinal increase in the percentage of blue birds toward Florida?

(3) The study of mated pairs. Is it true that there is no random mating, but a preponderance of matings of blue birds with blue birds and of white birds with white birds?

(4) Is there a difference in the breeding seasons of blue pairs and white pairs found on the same island?

(5) Are there any nests in which both parents are white, but some of the young are blue? Or, both parents blue and some of the young white?

THE GENETICS OF *Ardea occidentalis*

The older literature gave an altogether erroneous picture of the genetic situation. It stated that the white "species," *Ardea occidentalis*, met in the Keys the blue "species," *Ardea herodias* (in the subspecies *wardi*), and produced an intermediate hybrid, Würdemann's Heron. The true facts appear to be quite different. Since white as well as blue young are often found in nests, attended by a white and a blue parent, it is evident that a fairly simple mode of Mendelian inheritance is involved. The population of the Florida Keys is dimorphic, with a vast preponderance of white birds. The blue individuals of this population are not "normal" blue birds of the mainland type, but are, as Holt found out, more or less of the Würdemann type. There is good indirect evidence for the existence of a continuous inflow of blue genes from the mainland into the inner

Keys, resulting in an increased percentage of blue birds in this area and in the production of blue birds in which the "extreme" Würdemann characters are minimized.

In order to translate this information into the terminology of formal genetics we have to know first whether white or blue color is dominant. Mixed matings of white and blue birds do not give us this information. If both types of young are found in the nest and if white is dominant (white = W; blue = ww), such a mating would have the constitution Ww (white) × ww (blue). If blue were dominant (blue = B; white = bb), the genetic constitution of the parent birds would be: bb (white) × Bb (blue). Such back crosses of heterozygotes can shed no light on the question of dominance. What we need are cases where a cross of two similarly colored birds produces two kinds of offspring. This is possible only if both parents are heterozygotes (Ww or Bb). If both parents are white and yet produce white and blue young, then white (W) is the dominant gene, according to the formula: Ww × Ww = WW and Ww (white) and ww (blue). If both parents are blue, and yet produce blue and white young then blue (B) is the dominant gene according to the formula: Bb × Bb = BB and Bb (blue) and bb (white).

Are such pairings known? Mr. A. Sprunt writes me that he believes he remembers several cases where two white parents produced blue offspring. If this recollection is valid, it would prove that the white gene is dominant.

It is evident that this genetic model does not provide an explanation for Würdemann's Heron, with its pale color, shortened plumes, and lengthened bill. It is highly probable that these characters are produced by a whole complex of modifying factors which evolved in the Key population during its isolation. If, at the risk of over simplification, we should use the genetic symbol M for this modifying complex, and assuming white (W) to be dominant, we would have the following constitution for the three kinds of Herons:

Great White Heron	WW	MM
	Ww	Mm
		mm
Würdemann's Heron	ww	MM
		Mm
Great Blue Heron (Ward's)	ww	mm

It seems to me that such a genetic model is consistent with the facts as known up to the present.

I would like to acknowledge the great help I have had in this study from Robert P. Allen, Daniel B. Beard, James Bond, S. A. Grimes, and Alexander Sprunt.

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Museum of Comparative Zoology, Cambridge 38, Massachusetts, November 16, 1954.

ON THE LOONS OF BAFFIN ISLAND

BY GEORGE M. SUTTON AND DAVID F. PARMELEE

THREE species of loons breed on Baffin Island—the Common (*Gavia immer*), the Black-throated (*G. arctica*), and the Red-throated (*G. stellata*). Taverner (1934: 115) says that *immer* "does not seem commonly to extend north of Hudson strait and the western main coast [of the continent]." The latter part of this statement is probably correct, but in the southern half of Baffin Island *immer* breeds regularly and in considerable numbers.

We noted all three of these loons repeatedly in the summer of 1953, *immer* about the head of Frobisher Bay and at Lake Amadjuak; *arctica* in Frobisher Bay, at Lake Amadjuak, and at Cape Dorchester; *stellata* in all these areas and also at a large lake about 50 miles east-northeast of Wordie Bay. Our findings fortify Taverner's (1934: 114) and Soper's (1928: 78) statements concerning the widespread distribution and catholic taste of *stellata*. We did not, however, find *stellata* nesting about the mouth of the Jordan River.

Soper (1946: 14) found that in southwestern Baffin Island the areas actually inhabited by *immer*, *arctica*, and *stellata* to some extent supplemented each other. He reported *stellata* as common and *immer* as absent along the coast between Cape Dorset and Cape Dorchester in summer; *immer* as common and *stellata* as rare (or missing altogether) "on all fresh waters" in the interior between Andrew Gordon Bay and Tessikjuak and Ungmaluktuk lakes in September; and *immer* as rare, *stellata* as scarce, and *arctica* as common, about Bowman Bay in spring and summer. He mentioned one area of breeding overlap in middle Baffin Island: Nettilling Lake, a vast body of water in which *immer* and *arctica* both were "tolerably common" in summer. He summarized thus: "These facts make it plainly evident that the different species of loons may, on occasion, have well-defined and locally separated breeding ranges."

We had hoped to find *immer*, *arctica*, and *stellata* all nesting in the vicinity of the Royal Canadian Air Force Base (Lat. 63° 45′ N., Long. 68° 33′ W.) at which we had our headquarters, for we wanted to see how nesting ponds, nest-sites, and relationships between nest site and food supply differed among the three species. The only species we actually found nesting close to the Base was *stellata*.

We saw no loon of any species in flightless condition as a result of molt. Flying loons we saw as late as August 11 (*stellata*) and August 15 (*immer* and *arctica*). As early as July 29 we captured a flightless molting Common Eider (*Somateria mollissima*); and on August 3

and 4 we saw many flightless molting Canada Geese (*Branta canadensis*) and Blue Geese (*Chen caerulescens*). We suspect that many loons, if not most of them, molt their remiges in the fall or winter well south of their breeding grounds (see Sutton, 1943: 146).

COMMON LOON (*Gavia immer*)

Kumlien (1879: 103) found this loon "common" and breeding in Cumberland Sound. Soper (1928: 76) found it common in August at Nettilling Lake and learned from the Eskimos that it occurred "sparingly" about Merchants Bay in summer. Shortt and Peters (1942: 338) were told by the Royal Canadian Mounted Police at Pangnirtung that birds whose skins were used in Eskimo mats thereabouts were taken locally. Wynne-Edwards (1952: 358) saw the species in Frobisher Bay, but not at Clyde Inlet. We find no Baffin Island records for districts north of Nettilling Lake and Merchants Bay.

So frequently did we see a Common Loon in salt water just off the mouth of the Sylvia Grinnell, or flying up that river, that we felt sure at least one pair nested not very far north or northeast of the Base. On one occasion a wild laughing cry called our attention to the flying bird. The latest date on which we saw *immer* in this area was August 1.

On June 28, Eskimos brought to Robert Van Norman, of the Royal Canadian Mounted Police, the fresh flat skin (minus bill, wings, and feet) of a Common Loon recently shot just offshore from their village near the Base.

On July 13, near the mouth of the Jordan River, we saw a Common Loon flying low in wide circles over an Eskimo canoe not far from us. In this same part of the bay, during stormy weather on July 20, we chased two Common Loons with our motorboat, hoping to obtain a specimen. We approached close enough to ascertain that they were both adult.

On August 15, at Lake Amadjuak, we heard two Common Loons calling loudly for a short time in the early afternoon. Presently we saw two adults high above us. After they had circled two or three times on rapidly beating wings, they set their wings and soared in a graceful curve downward. They seemed to touch each other briefly during this descent. When their wings started beating again, the birds were about a thousand feet above the lake.

On August 8, 1955, an Eskimo named Eenutsia shot a Common Loon (male) in full breeding feather at the head of Frobisher Bay. The specimen was nicely prepared by Corporal Van Norman and presented to us by him. It measures: wing (arc), 367 mm.; tail,

71; culmen, 80.5; depth of bill at base, 26.0; tarsus, 88; outer toe, 114. Average for six Baffin Island specimens (sex undetermined) measured by Shortt and Peters (1942: 339): wing, 356; culmen, 79.4; depth of bill, 24.6; tarsus, 87.4; outer toe, 110.

BLACK-THROATED LOON (*Gavia arctica*)

Taverner (1934: 115) regarded "southern Baffin" as the northern limit of nesting for this species in eastern arctic America. Kumlien (1879: 103) found it breeding but "not common" in Cumberland Sound. Neither Dalgety (1936) nor Wynne-Edwards (1952) reported it from Clyde Inlet, but Shortt and Peters (*loc. cit.*) saw a single bird at Pond Inlet in September, 1938, and Soper (1928: 77) "tentatively referred to this species" certain loons seen near Pond Inlet in August. Soper (*loc. cit.*) saw the species repeatedly about Nettilling Lake in summer and felt that the west shore was "by reason of its low nature . . . particularly attractive and well adapted for nesting purposes." Preference for large lakes in low country seems to be characteristic of *arctica*. Rankin (1947: 50) found it nesting in northern Scotland only in large lochs in which "sudden influx from the surrounding country can be neutralised by the outflow."

Much to our surprise we did not see *arctica* near the mouth of the Sylvia Grinnell, about Tarr Inlet, or anywhere in the immediate vicinity of the Base. On July 13, we saw an adult in the bay about eight miles west of the Base and collected a male (GMS 11756) in full breeding feather at the open end of a nearly ice-bound lake in high country not far west of the Jordan River. This bird refused to fly despite our following it about, but we failed to find its mate or nest. It was the only loon we saw at any time in the Jordan River district. Its eye was dark carmine, with a narrow gray ring about the pupil (see Rankin: 1947, plate 44). The stomach was a well-defined gizzard filled with fish remains and gravel. The testes each measured about 20 mm. long.

At Lake Amadjuak, on August 8, we saw much of *arctica*. Having ascertained that four birds well out in the lake were all adult *arctica*, not two adults and their progeny, we observed two more adults flying in. During their final descent these newcomers held their necks strongly downward and their bills strongly upward, so the hinges of their jaws were almost, if not quite, as low as their feet (see Fig. 1). Of the six birds now in the water, three seemed to be paler on the head than the others. To our surprise the flock swam slowly toward us. When about 60 yards away they suddenly became active and noisy

FIGURE 1. Black-throated Loons coming in for a landing.

and started diving. Never were all six birds under at the same time. Just before diving, each gave a puppy-like yelp, but the usual cry between dives was the well-known *oo-loo-lee*, or a rough *karr* or *harr*, given with a thrusting forward of the head. We did not see *stellata* or *immer* anywhere in the immediate vicinity, but along another stretch of shore we saw two *stellata* flying high and heard others calling in the distance.

Near Cape Dorchester, on August 11, *arctica* and *stellata* seemed to be about equally common, and neither showed preference, so far as we could see, for any special sort of habitat. In a lake near which we had heard the *karr* of *arctica* several times, we finally discovered a half-grown, still downy chick and one of its parents. With a yelp and noisy pattering of feet the old bird flew off. The chick dived and we could not find it again until, some time later, both its parents returned. One adult alighted near the spot at which we had last seen the chick, the other in a separate pond not far away. The old birds repeated their clear *oo-loo-lee* again and again, occasionally in duet, and the chick answered with precisely the same call, in a thin,

slightly quavering voice. Witherby (1948: 120) does not mention any such call note as this.

On August 15, in a grass-rimmed pond half a mile from the southeast shore of Lake Amadjuak, we came upon an adult *arctica* and a well-grown chick. In an arm of the lake proper we surprised a company of eight adults, all of which flew at our approach but circled low, as if reluctant to leave.

Our male specimen of *arctica* measures: wing, 301 mm.; tail, 55; bill from nostril, 42; tarsus, 77. The crown, occiput and hind neck are very pale, and the bird represents the "small" race *pacifica*, though the following measurements are given by Witherby (1948: 123) for eight male *G. a. arctica:* wing, 280–335; tail, 50–61; bill from nostril, 40–50; tarsus, 72–80.

RED-THROATED LOON (*Gavia stellata*)

This species probably breeds throughout the whole of Baffin Island, even in the mountainous parts. Kumlien (1879: 103) found it "very common" in Cumberland Sound. Hantzsch (in Soper, 1928: 78) found it "the most common of the large birds" along the south shore of Nettilling Lake in July. Dalgety (1936: 585) found it "numerous among the many lakes from Eglinton Fjord to Clyde Inlet" in August. Shortt and Peters (1942: 339) saw adults and young at both Pond Inlet and Clyde River in September. Soper (1946: 15) called *stellata* "by far the commonest diver in the coastal areas of southwestern Foxe Peninsula" and said that in southeastern Baffin Island, where the species favored "lowlands with swampy lake surroundings," it nevertheless bred in "the most rugged and mountainous districts." In this respect *stellata* seems to be more adaptable than *arctica*.

We saw *stellata* several times in the vicinity of the Base in the latter half of June and in early July but did not find evidence of nesting until July 17, when, on a lake in the middle of Hill Island, we saw a pair of adults and two well-grown young. We failed to find *stellata* at all in the pondless flat country about the mouth of the Jordan River, and the only loon we found in the high land west of the Jordan was *arctica*.

On July 30, as we were crossing the tidal flats near Davidson Point, we saw two adult Red-throated Loons swimming in water only a foot or so deep. Seaweed was abundant here and the loons may have been obtaining food without diving. We expected them to dive, swim a long way under water, and re-appear at great distance, but instead they flew up, leaving the water with surprising ease.

On July 31, we heard two Red-throated Loons calling *cocka-crah-oh, cocka-crah-oh* over and over just west of the mouth of the Sylvia Grinnell River.

On August 3, at a pond in the middle of a great stretch of wet grass tundra just east of Tarr Inlet, we found two adults, a half-grown downy chick, and a nest holding one egg. The old birds flew from the pond without a cry as we approached. The chick, which dived well, evaded us for some time, but we finally shot it by lying in wait well back from the shore. The nest was a muddy mass of turf on a little island along the south shore. Well out in the pond was a rock on which a pair of Herring Gulls (*Larus argentatus*) had nested. A young gull, well feathered out but apparently unable to fly, was in the water not far from the nest-rock. The loon chick seemed to seek the company of this young gull.

On August 8 we saw a family of Red-throated Loons (two adults and two young) in the middle of a large lake about 50 miles east-northeast of Wordie Bay. That same day we saw two adult Red-throated Loons flying high above Lake Amadjuak and heard others calling in the far distance.

On August 11, near Cape Dorchester, we collected an adult male and female *stellata* (GMS 11837, -8) at a small pond in grass tundra bordering a low rocky ridge. We saw the pair fly in and alight and were surprised at being able to approach them so closely. Nowhere in that region did we hear the cries of *stellata*, but we heard *arctica* almost constantly.

On August 15, in a small tundra pond near Lake Amadjuak, we came upon an adult Red-throated Loon and a half-grown chick. The birds neither dived nor tried to fly, but swam deep in the water close to the opposite shore. At one end of the pond, in shallow water on a muddy islet several feet out from the bank, we found the empty nest. Not far away was part of the membrane of an egg.

Our adult male and female *stellata* measure: wing, 296, 272 mm.; tail, 49, 48; bill from nostril, 39, 34; tarsus, 76, 72.

ACKNOWLEDGEMENTS

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THE LANDING FORCES OF DOMESTIC PIGEONS

BY HARVEY I. FISHER

The force with which a bird lands on a perch may have considerable ecological and anatomical significance. This force, along with the body weight of the bird, may determine the type of perch used for roosting at night and the sequence of perches or landing areas used in approaching the nest, and it may even play an important role in habitat selection. For example, it is difficult to envision a Mallard or a Pintail Duck landing on even the larger branches of a tree, if one has ever observed the apparent force with which these ducks hit the water. Other ducks of similar body weight do land in trees. Large herons may be seen landing very lightly on the smaller twigs of trees and bushes and on soft mud; much lighter birds of similar pedal structure almost never utilize such landing places.

Such differences in landing may result from differences in habit, in structure, in behavior, or in the situation encountered. The force with which a bird lands is not solely a function of its weight; action of wings, of tail, and of legs modify this force, as does the pattern of landing.

For the student of functional anatomy, the landing force may be a means of studying the locomotor organs—wings, tail, and legs. In the literature we find no information relative to the forces with which any of these appendages move. Wind tunnel experiments to determine flight characteristics of airplanes are fairly successful because, compared to the avian wing, the wing of an airplane is very simple. It has been estimated that there are at least ten times as many variables in the wing of a bird. We cannot yet measure the force of the movement of the wing or the tail when these parts are in use, under natural or experimental conditions, although it is not difficult to imagine a large bird trained to fly with small transistors attached to various parts of its body to record a host of data.

Fisher (*in press*) has described an apparatus that makes possible the actual measurement of leg thrust when a bird takes off or lands. Knowing the force of the legs at the time of the take-off and the weight and speed of the bird, it is possible to calculate the force that must have been supplied by the wings during take-off. At the time of landing there are three major groups of variables—the parts of the wing, of the tail, and of the leg. If the force of landing of a bird is constant under certain controlled conditions, any change in one of these groups may be reflected in different forces being exerted by one or both of the other groups. Unfortunately, because the force

of only the legs can be measured at the time of landing, variation in wing force may be reflected in unmeasured changes in tail action, and the reverse is true.

The purpose of the present experiments was to ascertain the "normal" or "usual" force with which domestic pigeons landed. The usual force of an individual bird was to be compared with the force after surgical removal or impairment of a structure in that bird. It was soon learned that determination of the usual landing force was a major problem in itself and one with many interesting aspects. This paper is thus restricted to a discussion of usual landing forces; some 4000 landings were measured.

Materials and Methods

Domestic pigeons (*Columba livia*) were selected as the experimental birds for a number of reasons. There were on hand several pigeons that had been in captivity for one to three years and were used to handling. Young birds are easily raised in our sheltered, outdoor pens and provide a supply of birds of known age. The pigeon is large enough to make experimental surgery fairly easy, and yet it is small enough to have room to fly and otherwise live successfully in the outdoor cages.

Six pigeons were used in the present experiments: No. 54, male (3 years of age and originally a wild bird); No. 57, male (more than 3 years of age, raised in captivity); and Nos. 55, 101, 102, and 104, sex unknown (all approximately 1 year of age and raised in captivity). A major part of the work was done with No. 57 because he had been a pet of children, had been handled extensively, and was thought to be more easily trained. However, it was found later that all the birds readily adapted to the conditions of the experiments.

The apparatus used to measure the three vectors of landing force—down, back, and lateral—and the basic methods of its use have been described by Fisher (*in press*).

All experiments were conducted under exactly the same conditions. The same room was used, and it was thermostatically heated to 70° F. The flight tunnel was hung from the ceiling at an angle of 15 degrees from the horizontal landing platform. Both ends of the tunnel were wide open, but the birds, for some unknown reason, did not fly out the open end above the platform. The 12-foot length of the tunnel was determined after repeated field observations indicated that pigeons generally did not start their landing patterns farther than 12 feet from the perch. A single light suspended above the middle of the length of the tunnel provided the only illumination; the windows were at all times covered by dark shades. The thin walls of the tunnel permitted the light to pass through; the result was an excellent, soft light inside the tunnel and on the landing platform.

The landing platform was 15 inches in diameter, flat, and covered by hardware cloth with an eighth-inch mesh. The hardware cloth virtually eliminated slippage except on the most forceful landings. The flatness and rigidity of the platform must be noted, for it is likely that forces of landing would be quite different if a flexible, cylindrical perch (similar to a small branch of a tree) were used.

Before any experiments were started, the birds were kept in two small rooms, joined by a doorway, for several weeks. Between experiments they were returned to these rooms. By chance, the rooms were of such size and arrangement that the longest straight-line flight possible for a pigeon was about 10 feet. Food and water

were placed on a shelf, and the birds flew freely to them and to perches in the room. However, in no way did conditions in these rooms simulate conditions in the room used for experimental flights. In the holding rooms the perches were mostly wooden bars and window ledges.

ACKNOWLEDGMENTS

The Research Board of the University of Illinois provided funds for the construction of the measuring device. Miss Doris Krull aided in running many of the test flights, as did my sons, Fred, George, and James, and my wife, Mildred. Because of the need for close observation of each landing, one of the above persons worked with me each time birds were flown. My sincere thanks go to all of them and to the Research Board.

THE EXPERIMENTS

The original reason for initiating this work was to measure the function of certain parts of the pigeon's locomotor apparatus. It was planned that 100 landings per bird would be measured each week for three weeks, giving 300 landings to use as a "normal average" or control for each bird. It soon became evident that the force of landing changed during each day's trials and from week to week. Therefore, it was necessary to run extensive series of landing experiments to determine the nature and degree of these changes.

The general pattern of the experiments was to record the forces when the bird was landed at least 100 times on one day of each week. After several weeks of this the bird was to be landed 100 times at daily intervals for a week and for two-day intervals for a week. These trials were to be followed by landings at one-week intervals and finally by trials two weeks apart.

At least two birds were to be landed each day. They would act as a kind of control for each other to insure that possible differences between birds and between different periods of trials of the same bird were truly differences and not the result of unknown changes in method of handling, in temperature, or in the machine. This procedure was not possible each day; it was followed on 18 of the 30 days.

Moving pictures were made of some 300 landings.

The records of landings made on any one day were arranged in groups of 20 successive landings for statistical analysis. The heights of the curves recording down and back forces were measured to the nearest tenth of a millimeter, using vernier calipers. Lateral forces were unimportant in the present study except as they were used to note whether a bird landed properly and whether the record should be used. Statistical analysis was made of these measurements; the millimeters were not converted to grams, as is possible using the calibration of the machine (Fisher, *in press*). Conversion would have meant dropping fractional measurements, including possible errors in converting, and in general the obscuring of minor changes or differences.

Forces in grams are given in Figure 2 to present some concept of the forces involved in landing.

The machine is approximately twice as sensitive for down forces as for back forces. Therefore, a curve height of 13 millimeters for the down force equals about 2300 grams; the same height on the curve for the back force equals about 1100 grams. For simplicity, since millimeters were not converted to grams, total force is computed by multiplying the millimeters of down force by two and adding the millimeters of back force. Since all forces given are averages, there may be slight discrepancies in this calculation; these errors never amounted to more than 0.3

millimeters. Similarly, ranges given for total force are relatively meaningless because the extremes may be composites of records of different trials.

The data for total, down, and back forces of each day's trials were arranged as in Table 1. In this format it was relatively easy to make comparisons between successive groups of landings on one day (P values in right column) or between any group of these trials and the comparable group of another date.

TABLE 1

RECORDS OF ONE DAY'S LANDINGS BY PIGEON NUMBER 104

March 27, 1955. Weight: at start, 300 gms.; at end, 285					
Trials	*Mean in Millimeters*	*Range*	*Standard Deviation*	*Coefficient of Variation*	*Comments*
Total Force—no significant decrease from trials 1 to 100					
1–20	22.1±0.86	16.1–29.4	3.84	17.4	
21–40	21.5±0.51	16.6–25.9	2.30	10.7	P > .10
41–60	22.0±0.75	16.6–25.9	3.36	15.3	P > .10
61–80	21.4±0.70	15.0–27.6	3.15	14.7	P > .10
81–100	21.1±0.64	16.9–25.9	2.85	13.5	P > .10
101–120	18.7±0.80	13.8–28.2	3.57	19.1	P < .05
Down Force—no significant decrease from trials 1 to 100					
1–20	6.8±0.32	4.2–9.4	1.41	20.7	
21–40	6.6±0.18	5.1–7.9	0.82	12.3	P > .10
41–60	6.8±0.27	4.4–9.1	1.23	18.1	P > .10
61–80	6.4±0.24	4.7–9.2	1.08	16.8	P > .10
81–100	6.3±0.18	4.9–7.7	0.82	13.0	P > .10
101–120	5.7±0.31	4.1–9.1	1.38	24.3	P < .10
Back Force—no significant decrease from trials 1 to 100					
1–20	8.5±0.29	6.3–10.8	1.29	15.1	
21–40	8.2±0.24	6.4–10.7	1.07	13.1	P > .10
41–60	8.3±0.32	5.7–10.9	1.42	17.1	P > .10
61–80	8.6±0.30	5.6–10.7	1.37	15.9	P > .10
81–100	8.5±0.32	6.3–11.6	1.45	17.1	P > .10
101–120	7.2±0.30	5.6–10.0	1.35	18.8	P < .01

The experiments represented in this study include records of 2660 landings by pigeon No. 57 and 1320 records of other pigeons. The great amount of time involved in the flights and in the statistical calculations made it necessary to concentrate on one bird and to use the others to provide additional checks on the conclusions reached.

TRAINING AND HANDLING OF THE PIGEONS

It was anticipated that training the pigeons to land on the platform might be difficult. Training proved to be simple. The first time a bird was flown down the tunnel it was placed on the palm of the launcher's right hand. The person jiggled the hand to encourage the bird to fly off. If the bird did not land on the platform, and usually it did not, it was left to walk about in the tunnel for a few moments. Frequently it would eventually hop on to the solid landing platform at the end of the tunnel. If the bird did not fly off the launcher's hand and land near the platform after several such "free-flight" trials, another method was used. The pigeon was

grasped from below with its breast resting in the palm of the hand. The legs were extended posteriorly between the thumb and forefinger (to reduce struggling) and the bird's wings held against its sides. The bird was then tossed, headfirst, down the tunnel with just enough force to carry it to the platform. The bird usually flapped several times to make a halfway normal landing. If it landed on the platform, it was permitted to remain there and become acquainted with the surroundings before being flown again. After 10 to 40 such trials the birds would take off from my hand, without being thrown, and fly down to the platform. Apparently the important feature was for the birds to find out that there was a stable perch at the far end of the tunnel. Firm supports were purposely omitted from the floor of the cloth tunnel; when a pigeon landed on the floor of the tunnel it bounced about and had difficulty in balancing and walking. As soon as a pigeon climbed onto the platform from the tunnel or actually landed on the platform a few times, it seemed to be about as well trained to land there as it ever would be (Figure 8).

Thereafter, the procedure was to put the pigeon's feet on the horizontally held palm of the right hand, induce it take off by itself, fly through the tunnel, and land on the platform.

During these first flights the birds usually flew out into the room from the platform. They were caught in an insect net. After the first 20 to 40 trials each day the pigeons usually waited on the platform until I picked them up, always in the left hand, and carried them back to the upper end of the tunnel for other trials. When a pigeon failed to wait, it frequently flew to a perch in the room. On succeeding failures to wait to be picked from the platform, the bird usually chose the same perch. After the bird became used to this perch (3 to 10 times) I could walk up and grasp the bird with the left hand. These details of handling are presented to indicate that the pigeons were not frightened by the experiments or the handling; on only one or two occasions did a bird become excited and fly wildly about the room. At these times the bird was left alone in the room for 10 or 15 minutes or until it was quiet.

The hours required for a daily set of landings varied with the success we had in getting the bird started and with the number of landings we wanted on that particular day. On good days 100 landings could be recorded in about 2 hours, but sometimes it was 4 hours. On one occasion (January 8) 320 trials were made to obtain 220 successful landings. This required more than seven hours of more or less continuous work. Brief stops of perhaps 5 or 10 minutes were made each hour during this time, as indeed they were each day. Only on January 8 was fatigue made apparent by the behavior of any bird. It was assumed on later dates that fatigue in wings or legs would result in a bird landing with more force, as happened on this date

As will be discussed later, all birds used in this study maintained their body weights and were otherwise healthy, as far as could be determined.

THE PATTERN OF A NORMAL LANDING

Observation in the field and under experimental conditions indicated that a fairly definite procedure was followed in landing. Slow motion moving pictures were made and studied to determine the sequence of events. There are exceptions to the description given below, but it is characteristic of perhaps 80 per cent of all landings by uncaged pigeons. The same features were observed in the tunnel.

Flapping flight, with the body held horizontally, is maintained to within about ten feet of the perch. The feet are pulled up against the abdomen with the toes flexed. Approximately eight to ten feet from the perch the pigeon begins to take measures to reduce its speed—the body is tilted backward; the wings continue their beat; and the tail is spread and slightly depressed. The change in the inclination of the body and tail presents a broader braking surface to the direction of flight. Wing beats, with the changed inclination of the body, now act as forces to decrease the speed and to increase the lift.

As the pigeon approaches to within a foot or so of the platform, the long axis of the body reaches a vertical position and the long axis of the tail is also vertical; maximum breaking action is now being accomplished by the surfaces of the body and tail (Figure 1). With the body vertical, the wing beats now serve primarily as brakes to reduce forward motion. The last wing beat comes as the bird moves over the near edge of the platform. The bird is usually one to four inches above the platform (Figure 1).

Just before the feet touch the platform, the toes are uncurled and the legs are extended forward. The body tilts forward and the platform is touched. Moving pictures of the positions of the legs indicate that only in approximately 25 per cent of the landings are the two feet and legs extended uniformly. One foot is usually extended forward only; the other moves forward and laterally, apparently to act as a brace in balancing the final let-down. If the bird is not balanced by wing action prior to landing, it balances in the above-described manner. The bird may skid if forward motion has not been braked sufficiently, or the pigeon may hop or take two or three fast steps; it may even tilt backwards to provide an air brake, even though its feet are on the platform.

The person who started and stopped the recording device watched each experimental landing through a slit in the side of the tunnel. That person was not visible to the landing bird. From my position at the upper end of the tunnel, I too watched each landing. All abnormal landings could thus be eliminated from the records. It was sometimes difficult to judge the "normality" of a landing, and such selection of records might be termed selection of data. However, for the data to be comparable from trial to trial we used only those records in which the landings were as described. If the bird landed sideways, was obviously off balance, skidded abnormally, hopped when landing, or if its wings or tail touched any part of the tunnel or platform, the record was not included in the results reported here.

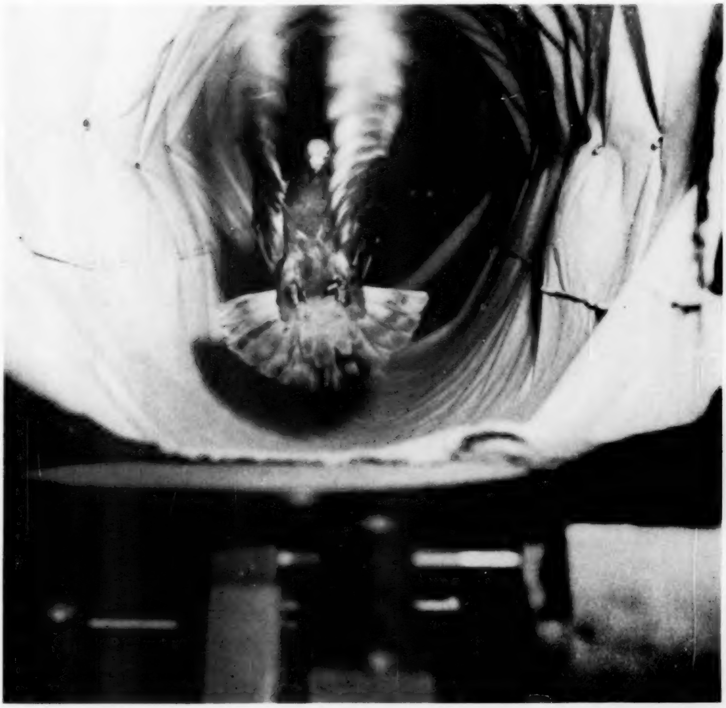

FIGURE 1. Domestic pigeon a moment before landing. Note the vertical position of the body, the widespread tail, and the toes which are being extended. The wings have just completed the last down beat.

THE RESULTS OF THE EXPERIMENTS

Changes in forces during a day's trials.—Figure 2 portrays the results of one day's landings by one bird. This particular day was chosen because it was fairly typical of most days and of most birds and because 200 successful landings were made in a continuous series. That the curves are representative may be checked by looking at each day's curves shown on Figures 3, 4, and 5.

Figure 2 shows that there is a decrease each day in total, back, and down forces. On this occasion the decrease was about 29 per cent of total, 28 per cent of down, and about 33 per cent of back force. As may be observed, the major decrease occurred during the first 80 trials. Another characteristic of the daily trials is a significant

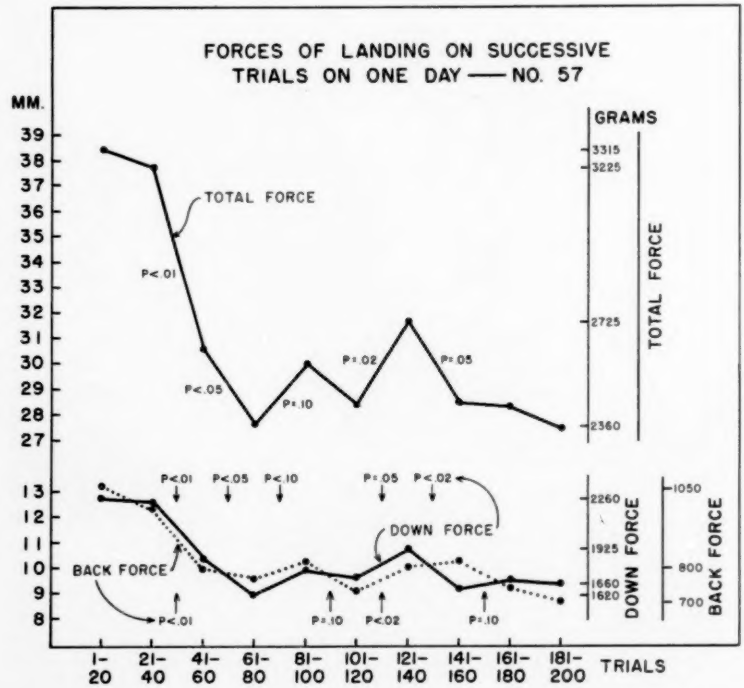

FIGURE 2.

increase following the described decrease. In Figure 2 the increase in force is shown between trials 80 and 140. Observations of Figures 3 to 5 will show that many of the daily trials show this increase.

The curves for down and back forces (Figure 2) aid in interpreting the changes in total force. The curve for down force rather closely approximates the one for total force. Back force declined sharply up to trial 60, held steady until trial 100 and then declined more or less gradually. Thus it appears that for this bird on this day the down force was more variable between successive sets of 20 trials but that it did not in general decrease as much as back force.

The magnitudes of the forces of pigeon No. 57 on this day were as follows: total force, 3315—2360 grams; down force, 2260—1620; and back force, 1050—700 grams. This same bird showed a maximum range of force over the period of the experiments, as follows: total, 4000—1850 grams; down, 2850—1400; and back force, 1150—450 grams.

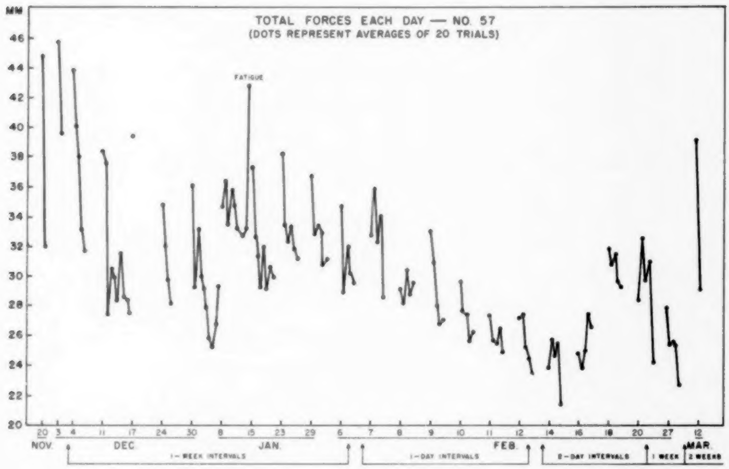

FIGURE 3.

The number of statistically significant changes that occurred between successive groups of 20 trials made on various dates by all birds is summarized in Table 2 (Omitted from this table are the data on No. 57 from February 6 to 12 when this pigeon was undergoing intensive work). *P* values higher than 0.05 were interpreted as indicating no change. About 50 per cent of the time all forces remained constant between sets 1 and 2 (trials 1–20 versus 21–40) on any one day; total force decreased 50 per cent of the time, back

TABLE 2

SUMMARY OF NUMBER OF SIGNIFICANT CHANGES BETWEEN AVERAGES OF SUCCESSIVE GROUPS OF 20 TRIALS

	Total Forces			*Down Forces*			*Back Forces*			
Between Groups	*Same*	*Up*	*Down*	*Same*	*Up*	*Down*	*Same*	*Up*	*Down*	*Number of sets of 20*
1 and 2	9	2	11	11	4	7	11	1	10	22
2 and 3	12	2	6	13	2	5	13	1	6	20
3 and 4	12	2	6	15	2	3	17	0	3	20
4 and 5	13	1	5	10	2	7	14	0	5	19
5 and 6	5	0	1	5	0	1	4	1	1	6
6 and 7	3	1	0	1	2	1	3	0	1	4
7 and 8	3	0	1	3	0	1	4	0	0	4
8 and 9	3	0	0	3	0	0	3	0	0	3
9 and 10	1	0	2	1	2	0	3	0	0	3
10 and 11	0	0	2	1	0	1	2	0	0	2

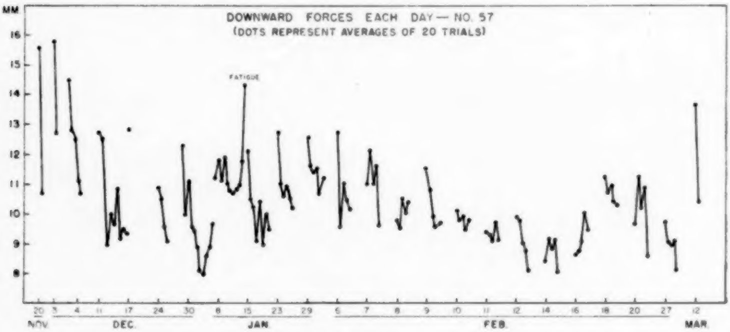

FIGURE 4.

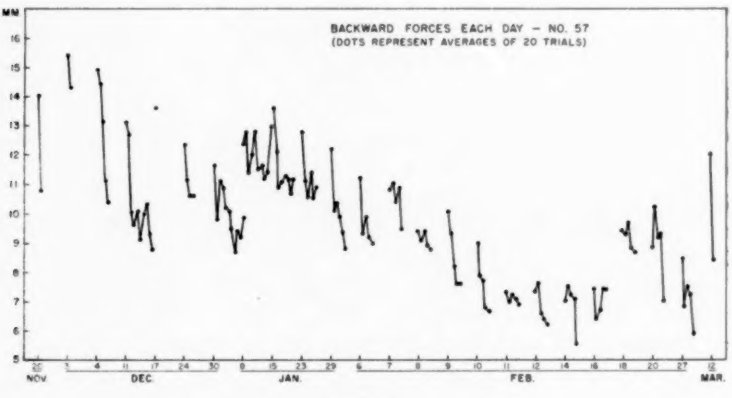

FIGURE 5.

force nearly 50 per cent and down force 30 per cent of the time. It seems then that back force tends to drop between sets 1 and 2 more frequently than does down force. None of the forces dropped as frequently between trial sets 2 and 3. About two-thirds of the time all forces remained the same, but again back force dropped more frequently. Between sets 3 and 4 and between 4 and 5 total forces dropped about as frequently as between sets 2 and 3. However, down forces tended to decrease more frequently than back forces, but both were more constant than in earlier trials. After the one hundredth trial (set 5) all forces remained approximately constant

until fatigue set in at about the one hundred and sixtieth trial. Although the number of sets beyond 5 are few, it is important that about only once in ten trials did down or back force decrease and only on four of twenty-five sets did down force increase significantly after the one hundredth trial.

One matter of significance is obscured, or at least not fully discussed, by this consideration of only those changes between successive sets of 20 trials. Minor, statistically insignificant changes may occur between successive groups of trials. If two of these minor changes were in the same direction, the sum of the two differences might be significant. For example, if minor decreases occurred between sets

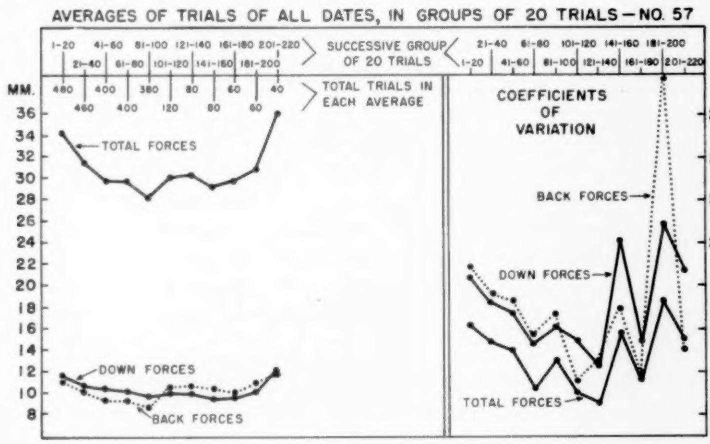

FIGURE 6.

1 and 2 and between 2 and 3, they would not be listed as decreases, but as no change. However, the difference between set 1 and set 3 might be a significant decrease. These possibilities were calculated and studied, but in no instance did they alter the pattern of changes described above.

Figure 6 was prepared to indicate the general trends, by use of simple averages, in the daily pattern of one bird. Compare Figures 2 and 6. The curves are nearly identical for the first 100 trials; all forces drop during the first 60 or 80 trials, but the upsurge in forces in Figure 2 starts 20 trials sooner than in Figure 6. Also note that down forces gradually decline as far as trial 160. Back forces decline more rapidly than do down forces during the first 100 trials of each date; between trials 100 and 120 (Figure 6) back forces increase sharply

before leveling off as far as trial 180 (in Figure 2 this increase is between trials 120 and 140).

After trial 160 the number of trials in each average is small, but a definite upward trend is apparent in all forces. These increased forces perhaps arise from fatigue. During some of these trials the bird was observed to stumble occasionally while walking, to have a high respiratory rate, to be listless, and to fail to preen after each flight as was its custom. After an hour's rest and an opportunity to feed and drink the pigeon was again alert and preened.

One other feature of Figure 6 must be discussed. The average coefficients of variation for each group of 20 trials on all dates are plotted. It may be seen that the coefficients decrease sharply as far as trial 80 each day, increase between trials 80 and 100, and reach their lowest values between trials 120 and 140. The pattern of change in the coefficients follows fairly well the pattern of change in the forces of the first 140 trials. We may conclude, therefore, that the average forces vary directly with these coefficients. For example, not only does the bird land with decreasing force during the first 80 trials, it lands with increasing uniformity (decreasing coefficients of variation) during these trials. Even though average forces of landing remain fairly constant from trials 80 or 100 to 160 or 180, there is an increasing lack of uniformity or increasing deviation from the average. This increase in variation may well be one of the first signs of fatigue in these birds.

TABLE 3

CHANGE FROM START TO TRIAL 100 ON EACH DAY, BIRD NUMBER 57

	Total Force in per cent	*Down Force in per cent*	*Back Force in per cent*
December 4	down 27.6 < .01*	down 26.2 < .01	down 30.2 < .01
December 11	down 21.9 < .01	down 21.3 < .01	down 22.9 < .01
December 30	down 19.1 < .01	down 22.7 < .01	down 12.1 < .02
January 8	down 0	down 1.8 > .10	up 3.2 > .10
January 15	down 14.2 < .01	down 14.1 = .01	down 14.4 < .01
January 23	down 16.5 < .01	down 17.3 < .01	down 13.3 = .02
January 29	down 16.1 < .01	down 14.4 < .01	down 22.9 < .01
February 6	down 14.5 < .01	down 19.7 < .01	down 19.6 < .01
February 7	down 12.8 < .01	down 12.7 < .02	down 11.9 < .05
February 8	down 1.7 > .10	up 6.1 > .10	down 6.4 > .10
February 9	down 18.2 < .01	down 15.7 < .01	down 24.8 < .01
February 10	down 11.5 < .01	down 3.0 > .10	down 25.5 < .01
February 11	down 8.8 < .10	down 3.2 > .10	down 5.5 > .10
February 12	down 13.7 < .01	down 18.2 < .01	down 15.1 = .01
February 14	down 9.7 < .05	down 4.8 > .10	down 21.4 < .01
February 16	up 7.3 > .10	up 10.5 < .10	0
February 18	down 7.9 > .10	down 8.0 > .10	down 7.4 > .10
February 20	down 15.2 < .05	down 11.3 < .10	down 21.3 < .01
February 27	down 18.6 < .01	down 16.5 < .02	down 30.6 < .01

* Second column of figures under each heading is of *P* values.

Table 3 shows changes in forces by percentages. The data lend further support to the view that all forces decrease significantly during each day's landings.

During the one-week period (February 6 to 12) of intensive work to which bird No. 57 was subjected, there was less evidence of a uniform decrease in all forces in the course of each day's trials (Table 3). Total force followed the usual pattern of decrease fairly well, but there was a lesser actual decrease because the total forces were relatively low to begin with and because the bird was approaching a minimal, terminal, total force each day. On three of these six days, down force was not significantly less on the one hundredth trial than

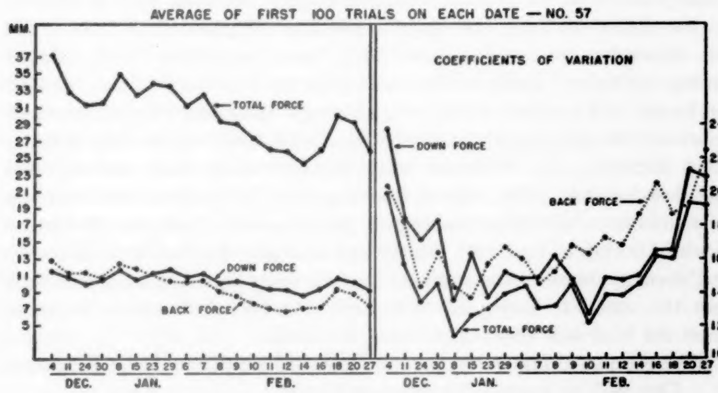

FIGURE 7.

on the first. On two of the six days, back force did not show a significant decrease from beginning to end.

Changes in forces from day to day.—The dates on which pigeon No. 57 was flown are indicated in Figure 7. The records of the landings of this individual on March 12, after an interval of two weeks, are not included in Figure 7 because only 40 trials were possible on this date.

It is apparent from Figure 7 and from Figures 3, 4, and 5 that the shapes of the curves for changes in forces over a long period of time are very similar to the curves for the changes in forces each day. At least this is true for the period of weekly landings. All forces decreased significantly the first week, and total and down forces decreased the second week. Beginning with the third week and ending with the fourth all forces increased somewhat. Although there were

changes in all forces between January 8 and February 6, these average figures show that forces used in landing on February 6 were essentially of the same magnitude as those of December 24 and 30. In other words, the bird was landing just as hard on February 6, after approximately 1800 landings, as it had on December 24 after only about 500 landings. (In Figure 7 we are using only the first 100 landings per date; see Figure 8 for total number on each date.)

It was concluded that the bird had reached a low level of forces which would not be further depressed by weekly periods of training. A series of daily landings was started on February 7. Total force and back force decreased throughout the period of daily trials. After a sharp decrease on February 8, down force declined very gradually in this period and for two days thereafter (Figures 3, 4, 5, and 7). The diverging curves for down and back forces are very evident during this time. Daily trials were halted on February 12 not because the forces had reached a plateau, although the similarity of forces of February 11 and 12 might indicate this, but because of the lack of time.

On February 14, 48 hours after the last daily trial period, total and down forces were still decreasing, but back force was starting to increase. All forces increased significantly between February 14 and 16 and 16 and 18. Statistical analysis showed that all forces on February 20 were the same as on February 18. We may conclude that the usual tendency at this time was for all forces to increase when the bird was flown at 48-hour intervals.

With a lapse of one week, forces decreased significantly on February 27. This will be more fully discussed later.

During the weekly trials the pattern of the coefficients of variation (Figure 7) shows the same characteristics as the coefficients for the trials during one day. Increasing uniformity of landing force (decreasing coefficients) within each average figure accompanies decreasing forces. However, it is perhaps significant that the relatively low (for this experimental work) coefficients attained by January 8, after approximately 1200 landings, were more or less maintained until February 7. The early part of the period for daily trials produced a sharp decrease in the coefficients of variation for down force. In other words, the bird was landing more uniformly as far as down force was concerned. Coefficients of down force increased with landings at 48-hour intervals and continued to rise until they were nearly as high as for the first trials of the experiment. Coefficients of back force started to increase with the beginning of daily trials and continued to increase until the end of the experiments.

The use of the average of 100 trials (Figure 7) shows major varia-

tions and the central tendencies, but it was possible that the averages were not accurate representations of the entire curve for each date. Average forces produced from data in such curves as shown in Figure 2 may be misleading. The averages may be unduly affected by any abnormally high or low part of the curve. In an attempt to check the accuracy of the representation by Figure 7, curves were prepared for all forces during the first 20 trials on each date and for trials 80 to 100 on each date. All these curves were similar to those in Figure 7, indicating that the first trials and the final trials of each day possessed the same characteristic changes over the period of experiment.

In general, then, we may say there is evidence for the following conclusions: 1) all forces decreased abruptly for three or four weeks after initiation of weekly periods of flights; 2) all forces increased slightly in the fourth to seventh weeks; 3) thereafter, all forces decreased gradually, but only slightly, until February 6, the end of the weekly trials; 4) back force started to decrease, after the slight increase, as early as January 8, and its decrease during weekly trials was far more evident than the decrease in down force; 5) when daily trials were started, all forces decreased more rapidly than when trials were at weekly intervals; 6) during daily trials back force again dropped more uniformly and more rapidly; 7) low forces attained with daily flights continued for at least two days after the period of these flights ended; 8) when the 48-hour interval was used, all forces increased sharply; 9) with any further lengthening of the interval between periods of trials the forces became greater, although for some reason the forces after a week's time decreased; and 10) coefficients of variation indicate increased uniformity of landing force as forces decreased, and decreased uniformity accompanied increased forces of landing.

FAILURE TO LAND SUCCESSFULLY

Failure to land successfully on the platform was frequent in the first training flights of each bird. This was expected, for the bird had to learn that there was a solid platform at the other end of the tunnel. What was not expected was that the number of such failures did not decrease with experience during each day's trials or during the three months of the experiments.

The curve in Figure 8 indicates that during each day's trials there was an increase in the percentage of failures until about the 100th or 120th trial. Between the 100th and 200th trials the percentage of failures decreased. The total number of trials in each group of 20 above 200 is too small to justify conclusions.

I am unable to explain the shape of the curve for successive sets

of 20 trials up to 200 trials. The increasing number of failures up to the end of 100 trials might have been explicable on the basis of fatigue except for the decrease in failures after 100 trials. It does not seem likely that the bird must each day land 100 times *before* it begins to learn to land successfully.

There is no evidence to indicate any pattern in the percentage of failures on successive trial days during the three-month period (Figure 8). The lowest percentage was 6.5 on December 11; the highest was 48.3 on December 3. The average of failures on the first 12 trial days was about 24 per cent; on the last 11 trial days it was 31

FAILURES TO LAND SUCCESSFULLY, BIRD NO. 57

	TOTAL TRIALS	PERCENT FAILURES
NOV. 20	40	15.0
DEC. 3	60	48.3
4	120	23.3
11	200	6.5
17	40	30.0
24	80	8.8
30	280	22.9
JAN. 8	320	29.7
15	220	25.0
23	180	26.1
29	180	33.9
FEB. 6	120	17.5
7	160	39.4
8	140	27.9
9	140	27.9
10	160	36.9
11	160	41.2
12	140	29.3
14	140	34.3
16	140	23.6
18	160	40.6
20	140	27.1
27	120	12.5

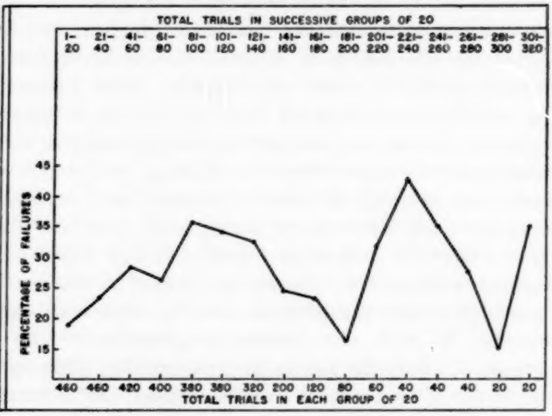

FIGURE 8.

per cent. The average percentage of failure for the landings of the daily trials during the week of February 6 to 12 was about 34; no decrease was noted.

One can only conclude that the bird did not improve in this part of its ability to land successfully under the experimental conditions imposed. It must be noted, however, that there are included, as failures, patterns of landing which are perhaps successful as far as the pigeon is concerned. Among these patterns are those in which the pigeon hopped one or more times on landing, turned sidewise just before touching the platform, landed with one foot off the platform, or landed on the extreme edge of the platform as if it were a twig perch. It is possible, but I think improbable, that inclusion of these obscured a pattern.

CHANGES IN MANNER OF LANDING

When the pigeons are first being trained, the initial records (Figure 9, December 4 and February 9) on each day are quite different from the later ones of the same date. Records of the same bird, after approximately 1500 more landings (Figure 9, February 9) are not like those of December 4. Not only are the forces less in each instance, the forces are applied more gradually and over a longer period of time. Once the bird has landed 30 to 40 times on the platform, no records of normal landings are as abrupt as that of trial Number

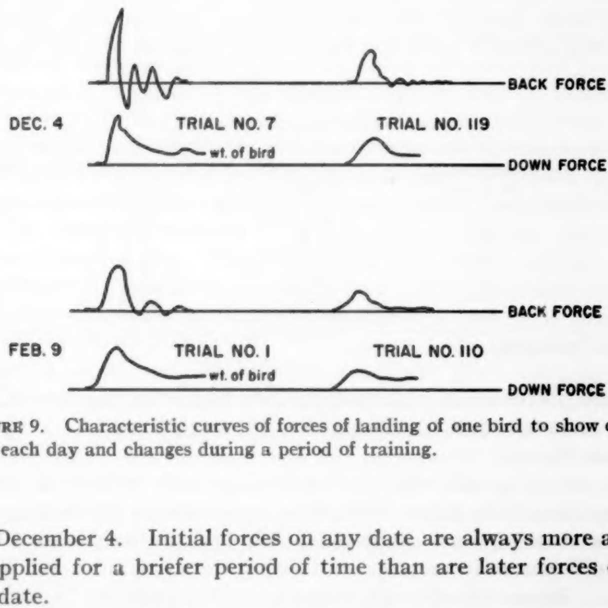

FIGURE 9. Characteristic curves of forces of landing of one bird to show changes during each day and changes during a period of training.

7 on December 4. Initial forces on any date are always more abrupt and applied for a briefer period of time than are later forces of the same date.

One may conclude that the bird has changed some details in its pattern of landing and is setting down without the extreme stresses of earlier landings. Even though actual forces may be as great in some later trials, a more gradual and "careful" landing is made. Fatigue in the muscles might be partly responsible for the change during any one day's landings, but there is something more here; the bird is not fatigued at the time of the initial trials on later days, trial Number 1 of February 9, for example, when the forces are not so abrupt.

BODY WEIGHT AND LANDING FORCE

Although the pigeons used in the experiment and the data are too few for definite conclusions, some facts are indicative. In Table 4 are data on body weight and landing forces of six different pigeons. For all practical purposes pigeons Numbers 54, 55, 101, 102, and 104 weighed the same. Yet, total landing forces varied from 21.1 to 36.2 millimeters, a range equal to about 43 per cent of the maximum. Down and back forces seemed to be equally variable in these birds of similar body weights; down force varied from 6.4 to 12.2, and back force from 8.2 to 12.2. Pigeon Number 57, which weighed nearly 100 grams more than the other pigeons, landed somewhat more lightly than Number 102 (particularly as regards down force) and only insignificantly more forcefully than Numbers 54 and 55, except

TABLE 4

BODY WEIGHT AND LANDING FORCE

Pigeon number	*Average weight in grams*	*Average forces of first 300 landings in millimeters* Total	Down	Back
54	328	29.6	10.0	9.6
55	317	29.4	9.9	8.6
57	407	33.4	10.7	11.7
101	320	23.7	7.7	8.4
102	329	36.3	12.2	12.2
104	293	21.1*	6.4*	8.2*

* Only 120 landings.

for back force which was considerably higher in the heavier bird. Note, however, that Number 102 had a back force just as great as that for Number 57.

We may conclude that differences in body weight of different pigeons have little to do with differences between the landing forces of these same pigeons. Individual differences in forces seem to result from differences in manner of landing, in approach, and in wing action. Pigeon Number 102 came in to the platform high and fast and virtually plopped into a landing. Numbers 101 and 104, however, came in easily and nearly hovered before touching the landing place.

It should be explained that body weight for any pigeon on any date is an average. Birds were weighed before and after the experimental landings; the average of these two was the weight used. Of passing interest only was the loss of weight, largely through voiding of excrement, that occurred during each day's trials. On days when 250 or more landings were made, birds lost from 15 to 24 grams (4.5

to 5.5 per cent of body weight). When only 140 to 180 landings had to be made to get the desired number of records, birds lost an average of 9 grams (5 to 18) or 1.6 to 4.0 per cent of body weight.

Changes in weight of an individual pigeon do seem to affect its landing forces. Data on three birds reveal that sudden changes in body weight are frequently accompanied by changes in forces. Since Figures 3, 4, and 5 show forces in No. 57, this bird will be used to demonstrate the effect of changes in weight. Between October 20, when the bird was first brought in for experimentation, and December 3, its weight rose from 375 to 420 grams. This increase was accompanied by an unexpected increase in all forces (Figures 3, 4, 5). Body weight increased from 437 grams on December 11 to an all-time high of 477 grams on December 17; on all the force curves the dot representing force on December 17 is above the expected position. On February 6, Number 57 was 30 grams lighter than on February 7 and 20 grams lighter than on January 29; total and back forces were less on February 6, but down force did not seem to be affected.

The intensive work of 100 landings each day for a week did not cause loss of weight (419 versus 412 grams). Nevertheless, on February 14 the weight of Number 57 was down to 391 grams and to 370 grams on February 16. These low weights no doubt played a part in producing the low forces of these dates. They may furnish part of the explanation for continued decreases in forces even after the end of the period of daily trials. Observation in the two rooms where the pigeons were kept showed that this large male (Number 57), which had been dominant, was now continually pecked, wing-flogged, and chased by two other males. Street lights kept the room semilighted at night and the bird had no opportunity to rest or feed. Apparently the fact that we had had this bird out of the room for three to six hours on each of seven successive days for trial landings had destroyed his dominance. Fatigue may have been another factor.

Number 57 was placed in a separate room on February 16. On February 18 his weight was up 61 grams to 431 grams. This sudden increase made the bird noticeably clumsy in landing on February 18 and 20, and all forces, except possibly down force, showed unexpectedly great increases.

On February 27 his weight was down to 400 grams and forces were generally lower than was expected.

Discussion and Summary

It has been demonstrated that pigeons weighing 300 to 400 grams landed on a flat platform with total forces varying from 1200 to 4000 grams. This total force was composed of a downward vector of 900 to 2800 grams and a backward or braking vector of about 300 to 1200 grams. These figures apply only to landings for which the bird approached at an angle of 15 degrees above the horizontal.

All forces decreased with repeated landings. During each day's trials (100 to 220 landings) forces frequently decreased by as much as 30 per cent. If a day's forces of landing by a single pigeon be plotted, the resulting curve is sigmoid in nature. All forces decreased over a period of three months of training. If the characteristic changes of this period be plotted, the curve is also a sigmoid.

Weekly periods of training at first resulted in sharply decreased forces, but these forces only gradually went slightly lower when weekly training was continued. When further training was at daily intervals all forces declined most abruptly, and this training may have carried over into the period when landings were made at 48-hour intervals. Using 48-hour intervals, all forces began to increase and continued to do so for the remainder of the experiment.

It is noticeable in all the curves depicting forces that back force is more affected by the interval of training than is down force. Changes in back force are greater and more rapid. In these experiments back force is really braking force to halt the forward momentum of the bird. This reduction of speed involves wing angles and beats and the inclination of the body and tail, among other things—a complex series of integrated activities. Down force, on the other hand, is apparently a simpler matter; the bird is nearly in a stall over the platform, is within a few inches of the platform, and just drops down.

Not only do the pigeons land more lightly after various periods of training, but the forces are more gradually and constantly applied. The curves on recordings of these later forces have broad, plateau-like peaks rather than the sharp peaks of the initial trials.

Body weight is not the major factor causing variation between the forces used by different pigeons. This variation is apparently a behavioral matter involving differences in patterns of landing. Changes in body weight of a single bird may affect its forces of landing on different days.

It is suggested that during these periods of training the birds have learned how to land under the experimental conditions, but each uses

his innate pattern of landing. This learning occurred during each day's trials, as evidenced by the sigmoid, learning curve of forces and by the increased uniformity of forces which is demonstrated by decreased coefficients of variation.

With this daily learning during the entire experimental period, it is remarkable that there was so little retention. At weekly intervals the initial forces were always much greater than the final forces of the preceding week; no major improvement was noted after the first three or four weeks, when the weekly interval was retained. When daily trials were started all forces decreased and the forces of landing were more uniform, apparently because the birds could retain a greater portion of what had been learned on the preceding day. These pigeons could not retain as much, or as well, over a 48-hour interval; forces increased and were less uniform than on the 24-hour interval. Intervals of two weeks may be long enough for pigeons to forget anything they may have learned about easing their force of landing. Only two such long intervals were used, but they do indicate this conclusion.

Our data indicated that the birds never demonstrated any continued improvement in finding the platform and in landing on it successfully. But, we have trained some pigeons for three weeks and then not used them at all for six weeks. After this interval they landed just as hard as they had when first flown, but they did find the platform immediately and did not require any retraining. They also waited to be picked up from the platform, as they had six weeks earlier. Thus, the evidence is not at all conclusive as regards retention of learning to find the fixed platform.

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Department of Zoology, Southern Illinois University, Carbondale, Illinois, May 10, 1955.

THE SEVENTY-THIRD STATED MEETING OF THE AMERICAN ORNITHOLOGISTS' UNION

BY HAROLD MAYFIELD, SECRETARY

THE Seventy-third Stated Meeting of the American Ornithologists' Union was held from October 25 to 30, 1955, at the Boston Museum of Science, Boston, Massachusetts.

BUSINESS SESSIONS

The Council met throughout most of the day on October 25 and briefly in the morning of October 28; the Fellows met on October 25 and 28; and the Fellows and Elective Members met together on the evening of October 25.

1956 Meeting. The Seventy-fourth Stated Meeting will be held at Denver, Colorado, September 4 to 9, 1956, by invitation of the Denver Museum of Natural History. Alfred M. Bailey is Chairman of the Local Committee on Arrangements.

Awards. The Brewster Memorial Award, by action of the Council, was presented to William H. Phelps of Caracas, Venezuela, for his contributions to avian taxonomy as particularly exemplified by his papers on the birds of Venezuela.

Marcia B. Tucker Awards in Ornithology were granted, by vote of the officers, to Stephen M. Russell, Baton Rouge, Louisiana; George F. Fisler, East Lansing, Michigan; Lester L. Short, David A. West, and Robert Wolk, Ithaca, New York. The sum of $455.00 was divided among these men in varying amounts to assist them in attending the annual meeting.

William H. Behle, Chairman of the Committee on Student Awards, reported that 'The Auk' is being sent free to 37 students, whose names were published in 'The Auk' for April, 1955.

Amendments to the By-Laws. An amendment concerning the election of vice-presidents was given preliminary approval by the Fellows and Council. It will receive final action by the Fellows at the 1956 meeting. The amendment will require changes in the By-Laws, as follows:

Article IV, Section 3. Add this paragraph after the first paragraph:

"One Vice-President shall be elected annually for a two-year term. He shall be designated Second Vice-President during his first year of office and First Vice-President during his second year. During the first year of validity of this rule one additional Vice-President shall be elected for a single year and serve as First Vice-President."

Article IV, Section 2. Instead of "All officers, except elected

members of the Council, shall be elected annually," read: "All officers, except the First Vice-President and elected members of the Council, shall be elected annually."

Article IV, Section 3, line 5, omit "for Vice-Presidents."

Article IV, Section 3, line 7, omit "two on the first ballot for Vice-President, and."

(See 'The Auk,' 1950, vol. 67, p. 222, for the complete text of By-Laws; and 'The Auk,' 1951, vol. 68, p. 95, and 1952, vol. 69, p. 70, for subsequent amendments.)

Reports of Officers. The Secretary reported that 3,220 copies of 'The Auk' were mailed in October, 1955. The Treasurer's records showed members by classes, as follows: Fellows, 72; Fellow Emeritus, 1; Honorary Fellows, 19; Corresponding Fellows, 62; Elective Members, 195; Honorary Life Members, 26; Student Members, 37; Members, 2,292. Other mailings go to institutional subscribers and to organizations exchanging journals.

The Treasurer's report is published in full in this issue of 'The Auk.' The Auditing Committee (Ira N. Gabrielson, Chairman, George H. Lowery, Jr., and Thomas R. Howell) examined the books of the Treasurer and reported them in good order.

The Editor, Robert W. Storer, reported that the last four issues of 'The Auk' have contained 498 pages, distributed as follows: articles, 319 pages; general notes, 44 pages; biographies, 22 pages; recent literature, 61 pages; A.O.U. business, 25 pages; index and contents, 27 pages. Col. L. R. Wolfe has prepared the annual index, and for the last three issues Frank McKinney edited the Recent Literature section.

Reports of Committees. A. W. Schorger, Chairman of the Committee on Biography, reported that ten obituaries were published in the year ending with the July, 1955, issue of 'The Auk.' During the year the Committee received notices of the deaths of 26 members:

Gertrude Strong Achilles, Member, June 18, 1955.
Warder Clyde Allee, Member, March 18, 1955.
Charles Foster Batchelder, Fellow, November 7, 1954.
Mrs. T. C. Beard, Member, April 30, 1955.
Arthur Cleveland Bent, Fellow, December 30, 1954.
Homer Lane Bigelow, Member, June 18, 1955.
Mrs. Frank Bond, Member, May 18, 1954.
Herbert William Brandt, Elective Member, March 8, 1955.
George Lister Carlisle, Jr., Member, December 22, 1954.
Austin Hobart Clark, Member, October 28, 1954.
Janusz Witold Domaniewski, Corresponding Fellow, March 20, 1954.
E. Raymond Driver, Member, August 14, 1954.

Roger Ernst, Member, March 29, 1955.
Evan Morton Evans, Member, March 17, 1955.
Frank Denver Haller, Member, September 22, 1954.
Stanley Gordon Jewett, Fellow, October 12, 1955.
Alice Leslie Walker Kosmopoulos, Member, June 25, 1954.
Charles Harold McNeese, Member, February 26, 1955.
Andrew William Obusek, Member, July 30, 1954.
Geoffrey Gream Ommanney, Member, July 18, 1955.
Theodore S. Palmer, Fellow, July 23, 1955.
Louise Franklin Perring, Member, September 16, 1954.
George Finlay Simmons, Elective Member, July 20, 1955.
Elizabeth Taber Taintor, Member, January 6, 1955.
Charles Alexander Van Arsdall, Member, July 21, 1954.
Grace Wyatt, Member, August 12, 1954.

Mrs. Herbert E. Carnes, Chairman of the Endowment Committee, reported payments into the Endowment Fund of $3,001.71. Douglas S. Miller, Chairman of the Committee on Nomination of Members, reported by mail that he had gathered on his Committee a large group of interested people representing major geographical areas in the United States and Canada. In the last year 188 new members have been enrolled.

Alexander Wetmore, Chairman, and Herbert Friedmann, Vice-Chairman of the Committee on Classification and Nomenclature, reported that the manuscript for the main body of the Fifth Edition of the Check-List of North American Birds is complete. It is hoped that details of editing (by Paul H. Oehser) and certain final checks to insure uniformity in treatment may be completed by late winter so the task of printing may begin. During the year the Committee has given consideration to 49 proposed changes in the accepted Check-List and has published 34 changes in the Thirtieth Supplement, which appeared in 'The Auk' for July, 1955, pp. 292–295.

Ira N. Gabrielson, Chairman of the Committee on Bird Protection, reported for the Committee. The full report appears in this issue of 'The Auk.'

Gustav A. Swanson, Chairman of the Committee on Vocational Information, reported by mail. He submitted to the Secretary a supply of reports, "Professional Training and Employment Opportunities in Ornithology," to be used in answering future inquiries. Believing that this report would fulfill the functions of the Committee for several years, he recommended the discontinuance of this Committee. The Council accepted this recommendation.

Frank A. Pitelka, Chairman of the Committee on Research, reported by mail that his committee considered its main function advisory and that it had not been called upon to function during

the year. Albert Wolfson, former Chairman of the Committee on Research, reported that the volume on research in avian biology would be issued by the University of Illinois Press in December, 1955.

Ralph S. Palmer, Editor of the proposed Handbook of North American Birds, reported that the Handbook Outline was published in May, 1955. A few copies are still available on request from the Handbook Editor. The first volume is planned to cover loons through ducks. Some portions of the manuscript of this and other volumes have been prepared, but there are topics for large groups of birds not yet assigned.

Election of Officers. At the meeting of Fellows and Elective Members, the officers of the previous year were re-elected, and three new members were elected to the Council for three-year terms to take the place of Jean Delacour, Harvey I. Fisher, and Herbert L. Stoddard, whose terms expired in 1955.

The Council re-elected the Editor of 'The Auk,' and elected three new Investing Trustees. The complete list of officers is shown on page 117.

ELECTION TO SPECIAL CLASSES OF MEMBERSHIP

FELLOWS

Robert P. Allen, Tavernier, Florida.
Charles G. Sibley, Ithaca, New York.
Milton B. Trautman, Columbus, Ohio.

HONORARY FELLOW

Julian S. Huxley, London, England.

CORRESPONDING FELLOWS

Hans Johansen, Copenhagen, Denmark.
A. J. Marshall, London, England.
Peter M. Scott, Gloucestershire, England.
C. K. Skead, Cape Province, South Africa.

FELLOW EMERITUS

Edward A. Preble, Washington, D. C.

HONORARY LIFE MEMBER

Jesse M. Shaver, Nashville, Tennessee.
Walter P. Taylor, Claremont, California.

PATRON

Raymond G. Guernsey, Poughkeepsie, New York.

ELECTIVE MEMBERS

Albert Ellis Allin, Fort William, Ontario.
Robert S. Arbib, Jr., Freeport, New York.
Mrs. Herbert E. Carnes, Tenafly, New Jersey.

L. Irby Davis, Harlingen, Texas.
William Ryan Dawson, Ann Arbor, Michigan.
Robert William Nero, Regina, Saskatchewan.
Dorothy E. Snyder, Salem, Massachusetts.
Arthur E. Staebler, Fresno, California.

ATTENDANCE

A registration fee was paid by 411 people from 28 states, the District of Columbia, 6 provinces of Canada, and 4 other countries. Those signing registration cards were as follows:

CANADA—*New Brunswick:* Mr. and Mrs. W. Austin Squires. *Newfoundland:* Leslie M. Tuck. *Nova Scotia:* Harrison F. Lewis. *Ontario:* Mrs. O. D. Boggs, W. Earl Godfrey, Mr. and Mrs. Hoyes Lloyd, Mr. and Mrs. W. W. H. Gunn, Margaret Knox Mitchell, David Munro, Mr. and Mrs. L. L. Snyder, Victor Solman, Mr. and Mrs. J. Murray Speirs. *Quebec:* Mr. and Mrs. J. D. Cleghorn, Mr. and Mrs. W. S. Hart, Mr. and Mrs. G. H. Montgomery, Mr. and Mrs. Lewis M. Terrill. *Saskatchewan:* Robert W. Nero.

ENGLAND—*Oxford:* William J. L. Sladen.

FRANCE—Mr. and Mrs. Lukas Hoffmann.

MEXICO—*Chiapas:* Miguel Alvarez del Toro.

UNITED STATES—*California:* Mrs. Harold C. Austin, Mr. and Mrs. Earle R. Greene, Mrs. Lillian K. Henningsen, Mr. and Mrs. Thomas R. Howell, Junea W. Kelly, Mr. and Mrs. Carl Koford, Mr. and Mrs. Alden H. Miller, Kenneth E. Stager. *Connecticut:* Mr. and Mrs. E. A. Bergstrom, Malcolm Gordon, Robert S. Lemmon, Paul S. Martin, Charles E. Mohr, Mr. and Mrs. Roger T. Peterson, Mr. and Mrs. S. Dillon Ripley, Aretas A. Saunders, Mrs. Eleanor Herrick Stickney, Reynolds Thompson. *Delaware:* Mr. and Mrs. Crawford H. Greenewalt. *District of Columbia:* John W. Aldrich, Thomas Baker, Charles H. M. Barrett, Walter F. Crissey, Albert M. Day, Philip A. DuMont, Herbert Friedmann, Frederick C. Lincoln, Mr. and Mrs. Alexander Wetmore. *Florida:* Allan D. Cruickshank, Mr. and Mrs. J. C. Dickinson, Jr., Anna E. Grimes, Samuel A. Grimes, Mr. and Mrs. John H. Storer. *Georgia:* H. L. Stoddard, Sr. *Illinois:* Mrs. Harry L. Baldwin, Karl E. Bartel, William J. Beecher, Emmett Reid Blake, Rudyerd Boulton, Nicholas E. Collias, Stephen S. Gregory, Karl Plath, Mr. and Mrs. A. L. Rand, Albert Wolfson. *Indiana:* Val Nolan, Jr. *Kansas:* Mr. and Mrs. Robert M. Mengel, Harrison B. Tordoff. *Louisiana:* Mr. and Mrs. George H. Lowery, Jr., Robert J. Newman, Stephen M. Russell. *Maine:* Mr. and Mrs. Alfred O. Gross, Charles E. Huntington, Howard Mendall, Rinda-Mary Payne, Mr. and Mrs. Olin Sewall Pettingill, Jr., Mr. and Mrs. F. Burton Whitman, Jr. *Maryland:* W. Wallace Bailey, David E. Davis, Jack P. Hailman, Seth H. Low, Mr. and Mrs. Chandler S. Robbins.

Massachusetts: Mr. and Mrs. Donald C. Alexander, Rosella S. Ames, Kathleen S. Anderson, Mrs. Paul E. Andrews, Arthur W. Argue, Margaret L. Argue, Phoebe G. Arnold, Aaron M. Bagg. Mrs. Theodora M. Bagg, Eleanor E. Barry, Lawrence M. Bartlett, Mr. and Mrs. Richard Borden, Harold I. Brown, Jerram L. Brown, Frances L. Burnett, Mrs. F. L. Burnett, Dorothy Caldwell, Mr. and Mrs. Lawrence B. Chapman, Nancy A. Claflin, Charles E. Clarke, George L. Clarke, Robert Verity Clem, Sydney Coffin, Mr. and Mrs. G. W. Cottrell, Jr., Davis H. Crompton, Mrs. P. S. Crowell, Mr. and Mrs. Eric Cutler, Henry H. Cutler, Richard T. Darby, William E. Davis, E. Russell Davol, John V. Dennis, Jared Diamond, Mr. and Mrs.

William H. Drury, Jr., Richard J. Eaton, Mrs. H. B. Elkins, Kimball Elkins, David I. Emerson, Ruth P. Emery, Mary Ferguson, Mrs. Dorothy D. Fordyce, Robert P. Fox, David L. Garrison, Mr. and Mrs. Timothy Goldsmith, Robert L. Grayce, Donald R. Griffin, Mrs. Mary Lela Grimes, Mr. and Mrs. Ludlow Griscom, Joseph A. Hagar, Edith M. Halberg, H. N. Halberg, Terrell Hamilton, H. W. Harrington, H. Warren Harrington, Jr., Stuart K. Harris, Stevens Heckscher, Carl W. Helms, F. Seymour Hersey, S. Higginbotham, Richard W. Hildreth, Norman P. Hill, R. M. Hinchman, Louisa Hunnewell, Bennett R. Keenan, Juliet R. Kellogg, Richard E. Kleber, Ralph Lawson, George Gardner Loring, Mr. and Mrs. C. Russell Mason, John B. May, Hubert E. Maynard, Mr. and Mrs. Ernst Mayr, Mr. and Mrs. Rosario Mazzeo, Mr. and Mrs. Edward McLaughlin, Gilbert E. Merrill, Andrew J. Meyerriecks, Eldridge A. Minard, Mr. and Mrs. Allen H. Morgan, Mr. and Mrs. Alva Morrison, Henry M. Parker, Raymond A. Paynter, Jr., Helen Peterson, L. Brayton Polka, C. Nathan Potter, Mr. and Mrs. Parker C. Reed, Mr. and Mrs. Samuel B. Robbins, Oscar M. Root, Marjory B. Sanger, Benjamin Shaub, Mary S. Shaub, Myrton T. Smith, P. William Smith, Jr., Dorothy E. Snyder, Roderick W. Sommers, John Stewart, Herman R. Sweet, Mr. and Mrs. Wendell Taber, Mrs. Wm. G. Taussig, Horace Taylor, John W. Terborgh, Louis B. Thacher, Jr., John Babcock Van Sickle, Charles L. Ward, Jr., William P. Wharton, Ralph E. Wheeler, Henry T. Wiggin, Mrs. James B. Worden. *Michigan:* Andrew J. Berger, George F. Fisler, Edith K. Frey, Philip S. Humphrey, Elmer J. Kuhn, Robert W. Storer, Mr. and Mrs. Josselyn Van Tyne, Mr. and Mrs. L. H. Walkinshaw, Mr. and Mrs. Harold Wing, Richard Zusi. *Minnesota:* Jean DeBell, Mr. and Mrs. W. J. Breckenridge, Beth Doeringsfeld, Mr. and Mrs. Francis Lee Jaques, Mrs. Colleen Helgeson Nelson, Arnold J. Petersen.

Nebraska: Mr. and Mrs. William F. Rapp, Jr. *New Hampshire:* George Burrows, S. Gilbert Emilio, Fred Greeley, Mrs. Cora Wellman. *New Jersey:* Mrs. Charles B. Andrews, Mrs. Herbert E. Carnes, Francis Harper, M. Albert Linton, Charles H. Rogers, Anne W. Wachenfeld, Helen J. Williams. *New York:* Heman P. Adams, Mr. and Mrs. Arthur A. Allen, Dean Amadon, Robert S. Arbib, Jr., Harold H. Axtell, Mr. and Mrs. John H. Baker, Esther Bennett, Walter Bock, Mrs. Albert R. Brand, Mr. and Mrs. Winston William Brockner, Carl W. Buchheister, John Bull, Victor H. Cahalane, Francis Cormier, William C. Dilger, Mr. and Mrs. Stephen W. Eaton, Don R. Eckelberry, Eugene Eisenmann, Mrs. Orry Evans, Devin Garrity, Mrs. Robert H. Gibbs, Jr., E. Thomas Gilliard, Lawrence I. Grinnell, James M. Hartshorne, Helen Hays, Byron T. Hipple, Jr., Mrs. Southgate Hoyt, Mr. and Mrs. Peter Paul Kellogg, Mr. and Mrs. John Kieran, Daniel S. Lehrman, Mercedeth Lovelace, R. S. Mathews, Mr. and Mrs. Donald McChesney, Mr. and Mrs. Harold D. Mitchell, Kenneth D. Morrison, Mr. and Mrs. Robert Cushman Murphy, Carlita L. Nesslinger, John T. Nichols, James R. Nolan, Ralph S. Palmer, Mr. and Mrs. Richard S. Pough, Theresa Putnam, E. M. Reilly, Jr., Mrs. Alexis L. Romanoff, Minnie B. Scotland, Mary P. Sherwood, Lester L. Short, Jr., Mr. and Mrs. Charles G. Sibley, Robert L. Smith, Robert C. Stein, Margaret Stewart, Mrs. Dayton Stoner, John K. Terres, Mrs. Carll Tucker, Mr. and Mrs. Edward C. Ulrich, Mr. and Mrs. Charles Vaurie, Nelle Van Vorst, Jason A. Walker, David A. West, Mr. and Mrs. Hudson S. Winn, Robert G. Wolk, Mr. and Mrs. Maurice J. Zardus, Jr. *Ohio:* Mrs. Robert V. D. Booth, Harold F. Mayfield, Kenneth Meyers, Mr. and Mrs. H. C. Oberholser, K. T. Rogers, William D. Stull, Mr. and Mrs. Milton B. Trautman, Elizabeth Trautman, Marian Washburn Thomas. *Pennsylvania:* Randolph Ashton, Mr. and Mrs. James Bond, Mr. and Mrs. Maurice Broun, Robert W. Glenn, Freder-

ick V. Hebard, Max Hensley, John F. Mehner, Mr. and Mrs. Raymond J. Middleton, Kenneth C. Parkes, Mr. and Mrs. Phillips B. Street, Elizabeth A. Taft, W. E. Clyde Todd, John E. Trainer, Mr. and Mrs. Harold Bacon Wood, Mr. and Mrs. Merrill Wood. *Rhode Island:* James Baird, Roland C. Clement, Mrs. Allan Davenport, Harold N. Gibbs. *South Carolina:* William B. Cotter, John H. Dick. *Tennessee:* J. C. Howell, Mrs. Amelia Laskey. *Virginia:* Mr. and Mrs. Ira N. Gabrielson, William S. James. *Vermont:* Thomas H. Foster. *Washington:* Donald S. Farner. *West Virginia:* Richard R. Bond. *Wisconsin:* Daniel D. Berger, John T. Emlen, Jr., Clarence S. Jung, Robert B. Klopman, Helmut C. Mueller, Mrs. Walter E. Rogers, Mr. and Mrs. A. W. Schorger.

VENEZUELA—*Caracas:* Mr. and Mrs. William H. Phelps, Jr.

PUBLIC SESSIONS

Papers sessions were held in the morning, afternoon, and evening of the three days beginning Wednesday, October 26, with the exception of the evening of October 28, when the annual banquet was held.

WEDNESDAY MORNING SESSION

The meeting was opened by a word of welcome by Bradford Washburn, Executive Director of the New England Museum of Science. Alden H. Miller, President, American Ornithologists' Union, responded. Harold F. Mayfield, Secretary, summarized the previous day's business meetings, including elections and awards.

Sapsucker Woods and the Cornell Trust for Ornithology (Slides). ARTHUR A. ALLEN, Cornell University, Ithaca, New York.

A Comparison of Ceilometer Mortality at Knoxville and Nashville, Tennessee, in 1951 and 1954. JOSEPH C. HOWELL, University of Tennessee, Knoxville, Tennessee.

Studies of Birds Killed in Nocturnal Migration (Slides). HARRISON B. TORDOFF and ROBERT M. MENGEL, University of Kansas, Lawrence, Kansas.

Initial Flight Directions of Homing Terns (Slides). DONALD R. GRIFFIN and TIMOTHY H. GOLDSMITH, Harvard University, Cambridge, Massachusetts.

The Fall Migration of Broad-winged Hawks Through Southern Ontario (Slides). W. W. H. GUNN. Federation of Ontario Naturalists, Toronto, Ontario.

A Survery of State and Provincial Laws Relating to Bird Protection. KENNETH D. MORRISON, National Audubon Society, New York, N. Y.

WEDNESDAY AFTERNOON SESSION

Arthur Cleveland Bent's "Life Histories of North American Birds." WENDELL TABER, Three Mercer Circle, Cambridge, Massachusetts.

The Role of Light and Darkness in the Dissipation of the Refractory Period in the Gonadal Cycle of the Junco and the White-throated Sparrow (Slides). ALBERT WOLFSON, Northwestern University, Evanston, Illinois.

Temperature Regulation in Nestling Least Terns and Nighthawks (Slides). THOMAS R. HOWELL, University of California, Los Angeles, California.

The Body Temperature of the North Island Kiwi (Slides). DONALD S. FARNER, State College of Washington, Pullman, Washington.

A Serological Analysis of the Anatid Classifications. WILLIAM B. COTTER, College of Charleston, Charleston, South Carolina.

The Sixth Edition of the AOU Check-List Should Include All of North America. EUGENE EISENMANN, 110 West 86th Street, New York, New York.

The Effect of Banding on Nest Desertion in Leach's Petrel (Slides). CHARLES E. HUNTINGTON, Bowdoin College, Brunswick, Maine.

Purple Sandpipers on the Massachusetts Coast (Motion picture). JOHN B. MAY, Cohasset, Massachusetts.

Sea Birds in Summer on Georges Bank, 1955 (Slides). ROBERT L. GRAYCE, Massachusetts Audubon Society, Boston, Massachusetts.

WEDNESDAY EVENING SESSION

The Machris Tres Marias Expedition (Motion picture). KENNETH E. STAGER, Los Angeles County Museum, Los Angeles, California.

Current Status of Peruvian Guano Production (Slides and motion picture). ROBERT CUSHMAN MURPHY, American Museum of Natural History, New York, N. Y.

Man and Nature Down Under (Motion picture). MAURICE BROUN, Hawk Mt. Sanctuary, Kempton, Pennsylvania.

THURSDAY MORNING SESSION

Descriptions of Newly-hatched Passerine Birds. ARETAS A. SAUNDERS, Canaan, Connecticut.

Simulated Juvenile Behavior by Adult Female Redwings (Slides). ROBERT W. NERO, Saskatchewan Museum of Natural History, Regina, Saskatchewan.

The Response of the Chicks of the Franklin's Gull to Parental Bill-Color (Slides). ELSIE C. COLLIAS and NICHOLAS E. COLLIAS, Illinois College, Jacksonville, Illinois.

Some Hostile Behavior Patterns of the Black Skimmer (Slides). ROBERT G. WOLK, Cornell University, Ithaca, New York.

Notes on the Life History of the Common Redpoll. ROLAND C. CLEMENT, Audubon Society of Rhode Island, Providence, Rhode Island.

Life History of the Nuttall Woodpecker (Slides). ALDEN H. MILLER, Museum of Vertebrate Zoology, University of California, Berkeley, California.

Notes on the Behavior of Falkland Flightless Steamer Ducks. OLIN SEWALL PETTINGILL, JR., University of Michigan Biological Station, Cheboygan, Michigan.

The Breeding Seasons of Some Birds in Chiapas, Mexico. MIGUEL ALVAREZ DEL TORO, Instituto Zoologico del Estado, Chiapas, Mexico.

The Development of Vocalizations in Meadowlarks (Recording and slides). WESLEY E. LANYON, University of Arizona, Tucson, Arizona.

Waking Times and Song Season. GEORGE F. FISLER, Michigan State University, East Lansing, Michigan.

Some Observations on the Nesting of the Anna Hummingbird. JUNEA W. KELLY, 1311 Grand Street, Alameda, California.

THURSDAY AFTERNOON SESSION

SYMPOSIUM ON BEHAVIOR AND CLASSIFICATION

MODERATOR: DEAN AMADON

Behavior and Classification—Some General Considerations. DEAN AMADON, American Museum of Natural History, New York, N. Y.

Problems in the Psychobiology of Species Differences in Behavior. DANIEL LEHRMAN, Rutgers University, Newark, New Jersey.

Behavior and Classification in Thrushes of the *Hylocichla* Group. WILLIAM C. DILGER, St. Lawrence University, Canton, New York.

The Evolution of Isolating Mechanisms in Birds. CHARLES G. SIBLEY, Cornell University, Ithaca, New York.

Summation. ERNST MAYR, Harvard University, Cambridge, Massachusetts.

Hybridization of Flickers in the Great Plains (Slides). LESTER L. SHORT, JR., Cornell University, Ithaca, New York.

Hybridization of Grosbeaks in the Great Plains (Slides). DAVID A. WEST, Cornell University, Ithaca, New York.

A Statistical Study of Hybrid Flickers (Slides). WILLIAM F. RAPP, JR., Crete, Nebraska.

Is *Compsospiza* a Valid Genus? JAMES BOND, Academy of Natural Sciences, Philadelphia, Pennsylvania.

THURSDAY EVENING SESSION

Music and Bird Song (Recording and slides). PETER PAUL KELLOGG, Cornell University, Ithaca, New York.

Comparison of Songs of Closely Related Birds (Recording and slides). ROBERT C. STEIN, New Hyde Park, New York.

Birds on Postage Stamps of the World (Slides). C. RUSSELL MASON, Massachusetts Audubon Society, Boston, Massachusetts.

The Life History and Behavior of the Adelie Penguin (Motion picture). WILLIAM J. L. SLADEN, Falkland Island Dependencies Survey, Scientific Bureau, London, England.

FRIDAY MORNING SESSION

SYMPOSIUM ON MANAGEMENT OF BIRD POPULATIONS

MODERATOR: DAVID E. DAVIS

Gull and Cormorant Management Along the North Atlantic Coast. ALFRED O. GROSS, Bowdoin College, Brunswick, Maine.

Management of Birds on Airplane Runways. PHILIP DUMONT, Fish and Wildlife Service, Washington, D. C.

Management of Mourning Dove Populations. JOHN W. ALDRICH, Fish and Wildlife Service, Washington, D. C.

Management of Migratory Waterfowl. WALTER F. CRISSEY, Fish and Wildlife Service, Washington, D. C.

Summary. DAVID E. DAVIS, Johns Hopkins University, Baltimore, Maryland.

Sexual Differences in Size and Food Habits in Three Species of Accipiter (Slides). ROBERT W. STORER, Museum of Zoology, University of Michigan, Ann Arbor, Michigan.

The Effect of Reforestation on Birdlife—a Preliminary Report (Slides). ROBERT LEO SMITH, Cornell University, Ithaca, New York.

John Abbot's Lesser Black Woodpecker. ELSA G. ALLEN, Cornell University, Ithaca, New York.

The Flight of Hummingbirds (Motion picture). CRAWFORD H. GREENEWALT, Wilmington, Delaware.

FRIDAY AFTERNOON SESSION

A Study of Breeding Shorebirds in the High Arctic (Slides). JOSSELYN VAN TYNE, Museum of Zoology, University of Michigan, Ann Arbor, Michigan, and WILLIAM H. DRURY, JR., Harvard University, Cambridge, Massachusetts.

The 1955 Expeditions of the Cornell Laboratory of Ornithology (slides and recording). ARTHUR A. ALLEN, Cornell University, Ithaca, New York.

Ecological Distribution of Breeding Birds in the Upland Forests of Southern Wisconsin. RICHARD R. BOND, Salem College, Salem, West Virginia.

Photographic Proof (Slides and Motion picture). DOROTHY E. SNYDER, Peabody Museum, Salem, Massachusetts.

A Simple Technique for Photographing Through Binoculars (Motion picture). WILLIAM J. BEECHER, Chicago Natural History Museum, Chicago, Illinois.

Brief Camera Studies: Eastern Fox Sparrow, Arctic Three-Toed Woodpecker, Greater Snow Goose (Motion picture). RANDOLPH ASHTON, Stevens Institute of Technology, Morrisville, Pennsylvania.

EXHIBITS

Among the ornithological exhibits in the Boston Museum of Science was a complete set of mounted specimens of the birds of Massachusetts and the original Fuertes and Brooks paintings used in Forbush's Birds of Massachusetts and Other New England States.

In the Art Gallery of Boston's Symphony Hall there was an exhibit of bird paintings by Paul Barruel.

At the Houghton and Widener libraries of Harvard University a number of interesting ornithological items were available for study: books, illuminated manuscripts, and illustrations dating from the Middle Ages to the present time, including original drawings by Audubon, Lear, and Gould.

SOCIAL EVENTS

The Fellows and Council Members met for dinner on the evening of October 25. Visitors were entertained with after-dinner coffee on October 26 by the Massachusetts Audubon Society and the Nuttall Ornithological Club. Tours through educational and historical features of the area (Cambridge, Concord, Lexington, The Wayside Inn, Boston, and Salem) were arranged particularly for wives of men attending the meeting on October 27 and 28. Members and guests were invited to a reception by Mrs. Marcia B. Tucker before the Annual Banquet on October 28. At the Banquet, K. T. Rogers of Oberlin College, Oberlin, Ohio, presented a lecture and motion picture in color entitled "The Ecology of the California Sierras and Canadian Rockies."

FIELD TRIPS

On Saturday, October 29, a number of people traveled by buses to the Newburyport-Plum Island area 40 miles northeast of Boston, where one of the attractions was the Purple Sandpiper. The itinerary included a visit to the Ipswich River Wildlife Sanctuary. Informal trips near Boston were arranged on Sunday, October 30.

RESOLUTION

Be It Resolved, That this Seventy-third Stated Meeting of the American Ornithologists' Union wishes to record formally its deep appreciation of the labor and the hospitality of the many individuals and organizations which have done so much to make this meeting a success, and, in this connection to mention particularly the Local Committee on Arrangements; The Boston Museum of Science, N. Bradford Washburn, Director; the Massachusetts Audubon Society; and the Nuttall Ornithological Club. Members of the Local Committee were as follows:

C. Russell Mason, *General Chairman.*

GENERAL COMMITTEE: C. Russell Mason, Ruth P. Emery, Ludlow Griscom, Richard T. Kleber, Ernst Mayr, Henry M. Parker, Marjory B. Sanger, Bradford Washburn.

EXHIBITS: G. William Cottrell, Jr., Eleanor E. Barry, Richard T. Kleber, Rosario Mazzeo, Gilbert E. Merrill.

FINANCE: Henry M. Parker, Richard J. Eaton, Allen H. Morgan.

PRINTING: Henry H. Cutler, Charles K. C. Chang, Stevens Heckscher.

RECEPTION: Joseph A. Hagar, Ruth B. Alexander, Lawrence M. Bartlett, E. Alexander Bergstrom, Charles W. Blake, John W. Brainerd, Lawrence B. Chapman, Osborne Earle, Stuart K. Harris, Philip B. Heywood, Ralph Lawson, Arthur W. Lyman, John B. May, Dorothy E. Snyder, Herman R. Sweet, Robert Walcott, William P. Wharton.

ROOMS: William H. Drury, Jr., Ellen D. Bennett, Mary B. Drury.

WOMEN'S TOURS: Margaret L. Argue, Annette B. Cottrell, Edith S. Griscom.

FIELD TRIPS: Ruth P. Emery, Wallace Bailey, Ludlow Griscom, Sibley Higginbotham, Allen H. Morgan, Henry M. Parker, Roger T. Peterson.

MEALS: Richard Stackpole, Elbridge A. Minard, Mildred L. Winship.

PUBLICITY: Richard Borden, Roland C. Clement, George Dock, Jr.

REGISTRATION: Marjory B. Sanger, Aaron M. Bagg, Edith M. Halberg, Bennett Keenan, Juliet R. Kellogg, Parker C. Reed, Oscar M. Root, Miriam Tilden.

VISUAL AIDS: Robert L. Grayce, G. Blake Johnson, Gilbert E. Merrill.

OFFICERS, TRUSTEES, AND COMMITTEES OF THE AMERICAN ORNITHOLOGISTS' UNION

	Expiration of Term
Alden H. Miller, *President*	**1956**
Ludlow Griscom, *First Vice-President*	**1956**
Ernst Mayr, *Second Vice-President*	**1956**
Harold F. Mayfield, *Secretary*	**1956**
Charles G. Sibley, *Treasurer*	**1956**
Robert W. Storer, *Editor of 'The Auk'*	**1956**

Elective Members of the Council

John T. Emlen, Jr.	**1956**
A. W. Schorger	**1956**
Albert Wolfson	**1956**
Ira N. Gabrielson	**1957**
George H. Lowery, Jr.	**1957**
Roger Tory Peterson	**1957**
S. Dillon Ripley	**1958**
Austin L. Rand	**1958**
Dean Amadon	**1958**
Thomas R. Howell, *Cooper Ornithological Society Representative*	**1956**
Maurice Graham Brooks, *Wilson Ornithological Society Representative*	**1956**
James P. Chapin, 1939–42	*Ex-Presidents*
Herbert Friedmann, 1937–39	*Ex-Presidents*
Hoyes Lloyd, 1945–48	*Ex-Presidents*
Robert Cushman Murphy, 1948–50	*Ex-Presidents*
Josselyn Van Tyne, 1950–53	*Ex-Presidents*
Alexander Wetmore, 1926–29	*Ex-Presidents*

Investing Trustees

Stephen S. Gregory, *Chairman*	**1956**
Clarence B. Randall	**1956**
A. W. Schorger	**1956**

Committees

Committee on Finance. Charles G. Sibley, *Chairman*. Ludlow Griscom, Harold Mayfield, Ernst Mayr, Alden H. Miller, Burt L. Monroe.

Committee on Endowment. Betty Carnes (Mrs. Herbert E.), *Chairman*. Margaret M. Nice, Herbert L. Stoddard, Josselyn Van Tyne, Alexander Wetmore.

Committee on Publications. The Editor of 'The Auk' (Robert W. Storer), *Chairman*. The President, the Secretary, the Treasurer, the Editor of the Ten-Year Index to 'The Auk' (Charles K. Nichols).

Committee on Program. George H. Lowery, Jr., *Chairman*. Thomas R. Howell, Harold Mayfield, Raymond A. Paynter, Jr.

Editorial Committee. Robert W. Storer, *Chairman*. Andrew J. Berger, William R. Dawson, John T. Emlen, Jr., Harvey I. Fisher, D. Frank McKinney, L. R. Wolfe.

Committee on the Brewster Memorial Award. Herbert Friedmann, *Chairman*. Dean Amadon, S. Charles Kendeigh, Frank A. Pitelka, Robert W. Storer.

COMMITTEE ON BIOGRAPHY. A. W. Schorger, *Chairman*. Jean Delacour, Hildegard Howard, J. Murray Spiers, Wendell Taber.

COMMITTEE ON NOMINATION OF FELLOWS AND ELECTIVE MEMBERS. John T. Emlen, Jr., *Chairman*. Dean Amadon, Harvey I. Fisher.

COMMITTEE ON NOMINATION OF HONORARY AND CORRESPONDING FELLOWS. Josselyn Van Tyne, *Chairman*. Ernst Mayr. S. Dillon Ripley.

COMMITTEE ON THE NOMINATION OF MEMBERS. William H. Drury, Jr., *Chairman*. (Membership to be announced later.)

COMMITTEE ON CLASSIFICATION AND NOMENCLATURE OF NORTH AMERICAN BIRDS. Alexander Wetmore, *Chairman*. Herbert Friedmann, *Vice-Chairman*. Dean Amadon, Frederick C. Lincoln, George H. Lowery, Jr., Alden H. Miller, Frank A. Pitelka, Josselyn Van Tyne, John T. Zimmer.

COMMITTEE ON RESEARCH. Frank A. Pitelka, *Chairman*. George A. Bartholomew, Jr., Herbert G. Deignan, John T. Emlen, Jr., Donald S. Farner, Harvey I. Fisher, Ernst Mayr, Robert Cushman Murphy.

COMMITTEE ON BIRD PROTECTION. Ira N. Gabrielson, *Chairman*. Jean Delacour, Ludlow Griscom, Hoyes Lloyd, Roger T. Peterson.

COMMITTEE ON STUDENT AWARDS. William H. Behle, *Chairman*. Joseph C. Howell, Robert T. Orr, Raymond A. Paynter, Jr., Harrison B. Tordoff.

LOCAL COMMITTEE ON ARRANGEMENTS FOR THE SEVENTY-FOURTH STATED MEETING. Alfred M. Bailey, *Chairman*. (Membership to be announced later.)

REPORT OF THE COMMITTEE ON BIRD PROTECTION TO THE AMERICAN ORNITHOLOGISTS' UNION, 1955

One of the most critical current problems presented to conservationists is the apparent unending enthusiasm of the Armed Services for invading and taking over wildlife refuges. There have been so many moves to take over wildlife areas that it appears to be a concerted effort by the services to get all they can while the getting is good. In some cases, the Department of the Interior has resisted these requests; in others, it has not.

One of the two most pressing is the effort of the Army to grab 10,700 acres of the Wichita National Wildlife Refuge (Oklahoma). The area they are asking for is the best turkey range on the refuge and furnishes important grazing for the bison and long-horned cattle. The Army tried a new tactic in this effort, and introduced an item of $1,000 into the Appropriation Bill for the administrative costs of transferring the area. When this was discovered, in spite of the last-minute efforts of conservationists, Congress approved the item. The Army, in effect, got Congressional approval for a raid on a wildlife refuge but did not formally approach the Department of the Interior until October. Secretary McKay objected vigorously to the transfer of any of this refuge to the Army. Every interested person should write and get their friends to write to the Secretary of Defense protesting this raid, and to the Secretary of the Interior approving the stand the Interior Department has taken in objecting to the transfer.

The second most important problem does not involve the actual invasion of a refuge, but the proposed extension of the Matagorda Island Air Field for photoflash bombing would bring these activities to the edge of the Aransas National Wildlife Refuge (Texas). When photoflash bombing was tried at the Salt Plains Refuge (Oklahoma), the ducks and geese left the area and did not return for a long time. It is feared that the Whooping Cranes will respond in the same way, and there are few places where they can go if they are driven out of Aransas. If this project is carried out despite the protests of conservationists, and the official protest of the Canadian Government, all the previous effort to preserve the remnant of the magnificent Whooping Crane may have been in vain. Great public opposition has stopped this project, at least for the present.

There are numerous other demands for refuge lands either in the incipient stage or out in the open. Some one of the Armed Forces is proposing to move in on a number of federal and state wildlife

areas. The Army wants to take over two magnificent game management areas developed by the state on a national forest in Louisiana. This is being fought by the conservation department and by conservationists in that state. The Air Force wants additional land on the Cabeza Prieta Refuge, and also a big block of the Kofa Refuge. These two areas protect the remnants of the Gaillard Sheep in the United States. The sheep have increased in numbers since these refuges were established, but if present proposals become effective, it is probable that the money and effort to save this fine mammal will have been wasted. There is also an Air Force proposal to take over a large part of the Desert Game Range which protects the Desert Mountain Sheep. Reports persist that the Navy is considering taking 4,000 square miles in eastern Montana which would include the Fort Peck Game Range, on which much time and effort has been spent by the Fish and Wildlife Service and other agencies. A fine herd of deer, antelope, and the associated small mammal and bird life will be jeopardized by this proposal which has not yet become very definite.

These are only samples. Other moves to take over big blocks of the Francis Marion and DeSoto National Forests were abandoned because of public protest. It is apparent that with the huge funds now at the disposal of the Armed Services, they are all attempting to acquire great areas of land. It seems from a civilian point of view that some of these areas could be used jointly. It is known that some of them are used only a comparatively short time each year, and if real cooperation existed among the Armed Services, some of them could be utilized more intensively than they are now.

These efforts are not restricted to wildlife refuges and national forest areas. It has just been learned that the Navy has moved into and occupied a considerable area in the Cape Hatteras National Seashore. It is not conceivable that the National Park Service failed to object, and it seems obvious that they were muzzled to prevent any information as to this proposed action reaching the public until it was an accomplished fact.

Legislation.—The last session of Congress considered much good and much bad legislation, and it is probable that the 1956 session will be equally important for conservationists. Two good laws were passed. The old mining law, which had been abused in many ways and which was being increasingly used to steal timber and other valuable public resources, was revised so that in the opinion of informed people more than 75 per cent of the abuses can be eliminated. The new law also provides a comparatively simple method of eliminat-

ing fraudulent or invalid mining claims without the necessity of long, drawn-out court action. The bill thus represents a distinct step forward, but some changes are still needed to eliminate the remaining abuses. This can be done without interfering with legitimate mining. The Mining Congress supported this revision, and this also represents a distinct gain, since it was the first time the industry has been willing to consider any corrective legislation.

Congress also passed a bill providing a method for distribution of the $13,500,000 surplus Federal Aid to Wildlife Restoration funds to the states. It authorizes this distribution over a five-year period on the basis of the present formula, but will require appropriation each year of this additional money by the Congress. It also broadens somewhat the uses that can be made of the money by adding the word "management." This will legalize some borderline projects which are good management and good conservation but which were difficult to approve under the language of the old law. In this way it makes it identical with the Federal Aid to Fisheries Act which has been in operation for a number of years without abuse.

Many bad bills were introduced, and conservation opposition was successful in keeping many of them in Committee. The Upper Colorado River Storage Project was passed by the Senate with Echo Park in it, despite an effort led by Senator Neuberger to delete the item. More senators voted to keep Echo Park out of the bill than had been anticipated in the short time that was available to gather support for the proposed amendment. The bill was reported out by the House Committee without Echo Park, but it was never brought up in the House since checks indicated that it would have been beaten badly if it were put to a vote. The bill still occupies a strategic position in Congress and will have to be vigorously opposed by conservation groups if this battle is not to be lost.

One bad break was the approval by the Armed Services Committee and later by the Appropriations Committee of the Army raid on the Wichita Refuge. There was nothing in either the authorization or appropriation bills which forces the Secretary of Interior to give this land to the Army, and so far Interior has opposed any such transfer. They have been willing to continue arrangements for use by the Army during certain periods, under a special-use agreement that has been in effect for a number of years without any undue interference with the wildlife or with the public use. There seems to be no good reason why such an arrangement cannot be continued.

Threatened species.—Such information as has reached your Committee regarding threatened species is indicated briefly here.

The status of the California Condor remains about the same and another year has passed without any verified report of an Ivory-billed Woodpecker.

The Trumpeter Swan population in the Red Rock Lakes and Yellowstone Park area is 590, or 52 less than the previous year. This population appears to be approaching a saturation point in this territory, and unless more birds can be successfully moved into new territory, it is not probable that this population will increase greatly. A small flock is being established at the Delta Waterfowl Research Station, using stock from both Peace River and from Red Rock Lakes. It is possible that these birds may be more easily transplanted than wild birds, although the birds transferred from Red Rock Lakes to Jackson Hole successfully established a small breeding colony.

It is presumed that all present have heard the May, 1955, report of the Whooping Cranes and nests in Wood Buffalo Park. The latest report, from the Canadian Wildlife Service, states that six young of the year were seen from the air on September 12. The birds have not yet migrated, so it is not possible to say how many of these youngsters will get to Aransas. The latest threat to this population has already been discussed.

A report by D. A. Woodside, a wildlife biologist, reached the Committee through Harold Coolidge, which indicates that on July 28th and 29th, at least twenty-two Nenes were seen in one small area. Twenty-two were counted on the 28th and twenty on the 29th, with the possibility that three others sighted are not included in the total. These birds appear to gather in this area between 4:00 and 5:00 P.M., and some signs indicate that they may be roosting there.

A letter, dated February 6, 1955, from Tatsuo Udagawa states that he was on Toroshima Island from January 18th to 30th. During that period he saw each day from eight to sixteen adult Steller's Albatross (Short-tailed Albatross), and believed that the maximum number was less than twenty. He reported seeing three nestlings and four unhatched eggs. The language of the letter is somewhat obscure, but it seems to indicate that these nestlings died when they were about 50 days old.

The Everglade Kite is reported to be in serious condition with a very small population still existing. Developments and proposed developments, if carried out, could interfere with the few remaining pairs, although the Fish and Wildlife Service hopes that the nearby Loxahatchee Refuge will provide suitable habitat and food for this species.

All available information indicates that the number of Attwater's Prairie Chickens continues to decrease as more of their habitat is developed agriculturally. Dr. Clarence Cottam, Director of the newly established Welder Wildlife Foundation, plans to try to establish a colony on the 8,000-acre area on which this institution will be located. The land lies within the original range of this bird, and preliminary arrangements have been made to secure birds for this effort.

General notes of interest.—The Cattle Egret now numbers several thousand, mostly in the Okeechobee area in Florida, and seems to be firmly established in this country.

The herons, egrets, and other long-legged wading birds continue to prosper and to extend their breeding range northward.

The Long-billed Curlew seems to be holding its own or perhaps increasing in numbers. The Chairman of this Committee recently saw on the Laguna Atascosa National Wildlife Refuge the largest concentration of this species in his field experience. He has visited the area frequently since before it was a refuge and has never seen as great a concentration of this fine shorebird.

An increasing number of reports regarding the killing of migrating birds by ceilometers are being received. As the number of these instruments increases, such kills may become important. The Committee does not have enough information to present any concrete suggestions at this time, but we believe that the Committee for the coming year might well gather information regarding the subject.

IRA N. GABRIELSON, *Chairman*
JEAN DELACOUR
LUDLOW GRISCOM
HOYES LLOYD
ROGER TORY PETERSON

Treasurer's Report, Fiscal Year Ending September 30, 1955

Income to Active Fund Account

Dues		
Fellows	$ 323.00	
Elective Members	765.00	
Members	9,522.55	
		$10,610.55
Subscriptions		1,437.25
Sale of back issues of The Auk		160.75
From authors for reprints		18.14
Royalty on Microfilms of The Auk		1.60
Miscellaneous sales		187.70
Advertising		572.00
Donations to Active Publications Fund		424.77
Committee on Arrangements, Madison meeting, 1954		634.45
Income from		
General Endowment		1,523.59
Ruthven Deane Fund		258.63
Balance in Active Account, 1954		2.94
Total Income—1955		$15,832.37

Special Funds

Brewster Memorial Fund		
Income from investments	$ 418.50	
Cost of 1954 medal		276.18
Honorarium to James Bond		142.32
	$ 418.50	418.50
Educational Endowment Fund		
Balance forward	$ 50.27	
Income from investments	77.16	
Committee expenses		6.74
To Active Account in partial payment for 37 Student Memberships		120.69
	$ 127.43	$ 127.43
(Owed to Active Account for remainder of Student Membership cost		27.31)
Bird Protection Endowment Fund		
Balance forward	$ 75.45	
Income, 1954–55	53.10	
Donation to International Committee for Bird Preservation		25.00
Donation to International Union for the Protection of Nature		10.00
Balance in Account		93.55
	$ 128.55	$ 128.55

Special Publication Fund		
Income, 1954–55	$ 276.29	
Endowment Fund		
Balance in uninvested funds from 1954	$ 665.64	
Life Membership payments	1,840.00	
Donations	41.00	
To Investing Trustees		2,500.00
Balance in Account		46.64
	$ 2,546.64	$ 2,546.64
Research Book Fund		
Balance forward, 1953–54	$ 3,203.45	
Orders paid in advance, 1954–55	96.00	
To University of Illinois Press in payment 547 orders		3,282.00
Balance in Account		17.45
	$ 3,299.45	$ 3,299.45
Handbook of North American Birds Fund		
Balance forward	$ 233.75	
Donations	5,600.00	
Supplies and Equipment		1,513.42
Balance in Account		4,320.33
	$ 5,833.75	$ 5,833.75
Marcia B. Tucker Fund		
Donation	$ 500.00	
To 5 Students to attend Boston meeting		455.00
Balance in Account		45.00
	500.00	$ 500.00

Disbursements

Manufacture and Distribution of The Auk	$11,287.06
Editor's Expenses	660.37
Secretary's Expenses	250.33
Treasurer's Expenses	480.65
Expenses 1954 meeting	202.34
Expenses 1955 meeting	187.00
Addressing service	246.42
Stationery, labels	14.00
Telephone and telegraph	6.05
Purchase and postage on back issues of The Auk	51.20
Mailing of back issues of The Auk	486.21
Preparation of membership roster	144.60
Bank charges and refunds	.50
Cost of dues notices	167.80
Endowment Committee expenses	152.07
Affiliation fee, A.I.B.S.	100.00
Donation, Zoological Society of London	25.00
TOTAL EXPENDED, 1955	$14,461.60

Total Income, 1955	$15,832.37	
Balance in Active Account, 1955	1,370.77	
Balance in Endowment Fund	46.64	
Balance in Special Publication Fund	276.29	
Balance in Bird Protection Endowment Fund	93.55	
Balance in Research Book Fund	17.45	
Balance in Handbook Fund	4,320.33	
Balance in Tucker Fund	45.00	
	$ 6,170.03	
Bank Balance, First National Bank, Ithaca, New York, September 30, 1955		$ 6,235.57

CHARLES G. SIBLEY, *Treasurer*

FRANK M. CHAPMAN MEMORIAL FUND

The Frank M. Chapman Fund was established to provide financial assistance to individuals conducting research in any branch of ornithology. The awards are usually made to younger scientists, in particular graduate students, but there are no hard and fast restrictions. Applicants should bear in mind that the field stations operated by the American Museum of Natural History are available for ornithological work. The Archbold Biological Station at Lake Placid, Florida, the Southwestern Biological Station in the Chiricahua Mountains of Arizona, and the Lerner Marine Station at Bimini, B. W. I., as well as the collections and laboratories of the Museum itself should be mentioned in this connection. When research sponsored by the Chapman Memorial Fund involves collecting it is expected that, after completion of the study, a representative series of specimens will be contributed to the Museum. A copy of published results of work supported in whole or in part by this Fund should be submitted to the committee and will, it is hoped, give credit to the Fund for the aid received.

Awards are made during the month of April. Applications should be received before March 31. Each applicant should state clearly the nature of the proposed research and give a careful estimate of the financial requirements of the project. Letters of recommendation should, whenever possible, be included. All correspondence should be directed to the Chairman, Chapman Memorial Fund Committee, Department of Birds, The American Museum of Natural History, Central Park West at 79th Street, New York 24, New York.

GENERAL NOTES

Observations on Birds "Hawking" Insects.—Cayonette (Auk, **64**: 458, 1947), Hodges (Auk, **67**: 242, 1950), Tucker (Auk, **67**: 243, 1950), and Brackbill (Auk, **69**: 88, 1952) have described the activities of the Starling (*Sturnus vulgaris*) as it catches flying insects in either flycatcher- or swallow-like flight. Snyder (Auk, **68**: 507, 1951) has described aerial feeding by the Ruby-throated Hummingbird (*Archilochus colubris*); and Schaefer (Auk, **70**: 411, 1953) says of the Swallow-Tanager (*Tersina viridis*) "Tersinas are accustomed to catching their insects flycatcher-like, on the wing." Cade (Wilson Bull., **65**: 52, 1953) has described aerial feeding on mosquitoes by the Rusty Blackbird (*Euphagus carolinus*).

This note describes the flycatcher-like activity observed for four additional species, the Blue Jay (*Cyanocitta cristata*), Catbird (*Dumetella carolinensis*), Bronzed Grackle (*Quiscalus quiscula*), and English Sparrow (*Passer domesticus*). Also a swallow-like flight of the Cedar Waxwing (*Bombycilla cedrorum*).

The evening of June 5, 1953, was warm (80° F), clear to slightly hazy, humid, with a mild variable westerly breeze. At 7:00 P.M. E.D.S.T., I first noted several birds hawking insects from large trees at the rear of our house in Amherst, Massachusetts. Blue Jays, Catbirds, Starlings, and Bronzed Grackles were all noted in this activity until 7:25 P.M. The pattern was essentially the same for each of the species involved. Each bird "took off" from an exposed perch, flew outward and upward to grasp a flying insect, then returned to a limb which was usually in quite a different spot from its original perch. One Blue Jay was seen to return to a limb before swallowing the insect which it had caught. Robins (*Turdus migratorius*) and Wood Thrushes (*Hylocichla mustelina*) were also present in the trees and on the ground, but were not observed in the hawking activity. Hawking ceased at 7:25, although flying insects could still be seen as late as 7:45 P.M.

On August 13, 1953, a group of English Sparrows was seen in the top of a tall elm tree about four miles north of Middlebury, Vermont. From 6:50 to 7:05 P.M. E.D.S.T. many individuals were seen to fly out and up, flutter as though to catch an insect, then return to the same or a near-by tree. Distance and light were such that I could not be sure that they actually captured flying insects, but their flight pattern indicated that they were feeding. On one occasion, a bird appeared to miss its prey, turned quickly, and made another "pass" at something before returning to the tree. Temperature was 74° F, wind fresh SW, sky cloudy, about three hours after a hard rain. A similar action by a single bird was observed on May 25, 1954, in Amherst, Massachusetts, at 3:45 P.M. E.D.S.T. The weather was warm, humid, and cloudy.

Late in the morning of July 24, 1954, a number of Cedar Waxwings were observed hawking insects over Leverett Pond, Leverett, Massachusetts. Several individuals were observed along the edge of the pond performing in a flycatcher-like manner as described above. In addition, one individual was observed flying back and forth over the open water of the pond. Its flight was much like that of a swallow except that it was not nearly as graceful. Its turns were jerky and slurring, and its flight in general much slower than that of a swallow.

Tucker (*loc. cit.*) indicates that a "swallow-like" flight of the Starling is common in England, and wonders whether it is really rare in the United States, as implied by Cayonette (*loc. cit.*). Brackbill (*loc. cit.*) records 43 observations of the swallow-like pattern as against 29 of the flycatcher-like pattern in 15 years of observations. Hodges (*loc. cit.*) feels that the swallow-like pattern is less common than the fly-catcher-like pattern. I have noted aerial feeding by Starlings as they gather in

trees at a roosting site in Amherst, Massachusetts. During 35 evenings of observation I have not seen any actions which I would call "swallow-like," but have often seen them fly up, hover, then glide back to a perch, after the fashion of an "awkward" flycatcher.

Cade (*loc. cit.*) feels that aerial feeding by Rusty Blackbirds occurs more frequently when crawling insects are scarce and flying insects are abundant. The relationship between availability of "satisfactory" food items and the actual food taken has been amply demonstrated for other species and undoubtedly plays a part in determining the frequency with which a particular species resorts to an aerial feeding habit.

Beecher (Auk, **70**: 270, 1953) has recently suggested a phylogeny of the Oscines which would derive the Sturnidae and the Hirundinidae from a common ancestry. If this relationship is correct, it would not be surprising to find a swallow-like aerial feeding habit common to the two groups. However, the Bombycillidae, Corvidae, Icteridae, and Ploceidae, and to a lesser extent the Miminae, are farther removed from the Sylviidae which form the starting point of Beecher's phylogeny. It should be noted that "hovering" to pick off insects is a characteristic habit of sylviids. This may well be a basic behavioral pattern which has become variously modified in the many lines radiating from the sylviids. It would seem worth while to collect additional records of the aerial feeding habit to determine the distribution and patterns of this habit among the Oscines. If this is to be done, some standardization of terminology is desirable. I therefore propose the following classification of terms as a starting point:

I. *Aerial Feeding*. Any feeding accomplished while the bird is "on the wing."

A. *Hovering*. The method commonly seen in the Kinglets, Chickadees, Vireos, and Wood Warblers, in which the bird jumps up a few inches from one branch, and hovers on fluttering wings while picking off its food from another twig.

B. *Hawking*. Any feeding during the flight of a bird while it is more than three feet from a perch (the "three feet" is purely arbitrary).

1. *Swallow-like* (Hirundinoid). A continuous series of passes through an area. This would imply the completion of a flight pattern at least approaching a double figure "8."

2. *Flycatcher-like* (Tyrannoid). A single sortie from an exposed perch back to another perch, broken in the middle by a fluttering flight during which the insect is captured.—L. M. Bartlett, *Department of Zoology, University of Massachusetts, Amherst, Massachusetts.*

Notes on Courtship Behavior of Wild and Tame Blue Jays.—Courtship behavior of Blue Jays (*Cyanocitta cristata*) as described below, was witnessed in wild birds which nested close to my home and jays confined indoors in Bethesda, Maryland. A pair of jays appeared in the yard on March 18, 1953, and on March 31 began nest-building in a clump of honeysuckle (*Lonicera japonica*) hanging 12 feet up in a pine tree. At 7:30 a.m. on April 9 both jays were 15 feet up in a hickory, about 25 feet from the nest tree. The female sat on a limb while the male hopped from one limb to another, keeping within a foot of her, with his feathers ruffled up and making "quick, quick" notes. She perched stiffly upright. After a few moments the jays stood facing each other on the same limb with bills open and touching briefly. Then the male mounted and coition, lasting several seconds, took place. Afterward the male flew away. The female, however, remained on the same limb, fluttering her wings. She did not appear to be preening or smoothing out her feathers. That evening one jay was observed to feed the other, a performance witnessed on subsequent days but not prior to coition. I did not disturb the fairly inacessible

nest to determine when eggs were laid. Two young ones left the nest on May 21.

A jay captured on July 10, 1952, shortly after it left the nest, lived in my library through the winter, its cage door being open most of the time so that it became tame. When 11 months old in May, 1953, the jay developed new patterns of behavior, apparently sexual in motivation and subsequent evidence showed the bird to be a male. As I approached him in the evening he would hop from a shelf to my shoulder, facing one way, then the other as he kept up low, rapid whistlings in my ear and rubbed his bill in my hair. That these actions represented courtship was indicated by subsequent behavior when two juvenal jays were introduced into the library on May 18. On May 19, the older captive perched beside the largest of the young, fluttering his wings, making low whistles, and running his bill through the young bird's plumage. The next evening, after a similar performance, the older jay attempted coition. The young jay, however, never responded to his advances.

The situation was different for a younger jay which I had removed from the nest in the yard three days before the other young left naturally. For the first week this bird fluttered its wings and begged food from me. By May 25, the year-old captive male had taken over feeding the youngest jay. This he did with great enthusiasm, dismembering many cicadas in the process. No sexual behavior was noted until May 31, when the male hopped from one side of the young jay to the other, making low notes and poking its plumage with his bill. Then he mounted and attempted coition. On succeeding evenings the year-old male would hop over, above, and below the young jay before mounting when the young one, being half his size, was pressed fairly flat. Occasionally the former would stand high as to look down on the juvenal bird's back and sing an odd song which he had developed during captivity, presumably as a prelude to coition.—LAWRENCE KILHAM, *109 South Fourth Street, Hamilton, Montana.*

An Egg-bound Mourning Dove.—The condition known as egg-bound is not uncommon in caged wild birds and in domestic fowls. However, in wild birds in the natural state it is rarely, if ever observed.

A Mourning Dove (*Zenaidura macroura*) with an egg-bound condition was called to my attention by Mr. Merritt Paulson, a farmer, who has permitted an extensive study of this species to be made on his property near Barrington, Illinois. The dove was found prostrate on the ground under a tree. At this time an egg was protruding part way out of the cloaca. A bystander advised him to break the egg, which was done. Then, the dove struggled free, flew for a distance of about 75 yards, and again fell prostrate to the ground, where it was recovered.

The bird was in a very weakened condition, had lost the use of its legs, and could not maintain its equilibrium. The area surrounding the cloaca was swollen and covered with blood and fecal matter. This was washed with warm water to permit examining for a prolapse, which was not present. The bird expired about 3 hours after being relieved of its first egg.

Post-mortem revealed the following: weight 102.8 grs., crop empty. The gizzard contained grit and a small amount of unidentifiable dark green fibre. The inner-lining of the gizzard was colored a very dark green, similar to a condition often found in lead-poisoned waterfowl. Gonads indicated active follicles of which two were collapsed, including one which had partly receded. The second egg was in the oviduct adjacent to the opening of the cloaca and measured 29×20.5 mm., which is normal in size. The posterior half of the egg was encased by a normal fully calcified shell, the anterior half was very thin and rubbery.

Ward and Gallagher (1920, "Diseases of Domesticated Birds," p. 165) and Levi

(1941, "The Pigeon," p. 301) state the cause of the inability to extrude an egg (egg-binding) may be due to: inflamatory or infection of the oviduct or cloaca (*Salpingitis*), a stricture or tumor in it, or its prolapse; a malformed, over-sized or soft shelled egg; and in younger birds the egg passage may not have developed enough to accommodate a normal egg.

Karl Plath of the Chicago Zoological Society, Brookfield, Illinois, in conversation said that chilly weather is conducive to egg-binding.

Probably an egg-bound condition in Mourning Doves is uncommon, but possibly it is one of the many minor mortality factors.

I wish to thank Dr. A. L. Rand of the Chicago Natural History Museum for help in this study.—CHARLES W. KOSSACK, *715 Division Street, Barrington, Illinois.*

Starling at Vanderhoof, British Columbia.—In the autumn of 1953, relatively large numbers of Starling (*Sturnus vulgaris*) appeared in the Lakes District, a small farming community 10 miles south of Vanderhoof, British Columbia. The birds were first detected early in the morning of September 17 by Mrs Edward Dickson, who reported to me by telephone a few minutes later that a flock of "short-tailed, white-spotted blackbirds" was in a grove of aspens close to her house. When I arrived at the Dickson farm shortly afterwards, a compact flock of approximately 120 Starlings was located on an oatfield where the grain was in shock. The birds were restless, flying from one part of the field to another, and did not permit me to approach within shot-gun range. On September 18, a flock of 60 alighted in several cottonwood trees at a place about 2 miles east of the Dickson farm. From the cottonwoods, the Starlings flew to an adjacent field, which had recently been ploughed and foraged there until I walked towards them, when all flew off together and disappeared from view. At about the same time, other flocks were reported by local residents on the Dickson farm and elsewhere. Subsequently, until I left the district on September 30, Starlings were noted daily and the total population was estimated to be approximately 250. Usually they were in small flocks numbering up to 25 individuals, but on one occasion, September 28, a flock of 75 was recorded. Information was received later that flocks had been seen in November and in January and March, 1954. None was observed by me during the period May 20 to June 6, 1954.

The stomachs of seven specimens collected in September, 1953, of which five were birds of the year, contained pulp and pits of choke cherry *Prunus* sp., exclusively.

An unusual feature of this invasion is the relatively large number of individuals involved. Earlier records of the species in British Columbia were of single birds, nesting pairs, and small nimbers accompanying flocks of Red-wings or Brewer Blackbirds (Munro, Murrelet, **34**, (2): 15–17).

Another point of interest is in the locality concerned. The Lakes District is approximately eight miles south of the 54th parallel of latitude. The nearest locality of reported occurrence is Williams Lake, some 180 air-line miles to the southeast.

The place of origin of these Starlings is a matter for speculation. In this connection it may be pointed out that some elements of the central British Columbia bird population, e.g., Purple Finch, White-throated Sparrow, Clay-colored Sparrow, Swamp Sparrow, and others, enter the region from the east—not from the south where these species are but casual migrants. Most certainly there exists an east-west migration route into and from this part of British Columbia. Perhaps it may be inferred, then, that the Starling invasion reported above originated in prairie farming communities east of the Rocky Mountains. J. A. MUNRO, *Okanagan Landing, British Columbia.*

Duck Blinds as Nesting Sites for Great Blue Herons on the South Texas Coast.—Many birds have adopted man-made structures for nesting sites. In the majority of cases these sites directly involve or are at least close to human habitation. The case related here seems to be important enough to affect the general welfare of one large bird, over several hundred square miles, but it involves a simple man-made structure, always far distant from any human habitation.

Redfish Bay on the south Texas coast is largely an area of shallow flats only a few inches deep. In winter it is frequented by several species of anatine ducks. With the ducks come the hunters and their blinds. On the Texas coast the blinds are covered with brush cut from heavy stands of the Sweet Bay (*Persea borbonica*). These stand throughout the year and some 200 or more spot the whole bay along the Port Aransas causeway, which leads across the bay to Harbor Island.

While riding in a boat across this bay with Mr. Vernon N. Johns, the National Audubon warden, on May 20, 1954, I noticed that many duckblinds had one or more Great Blue Herons (*Ardea herodias*) standing on top. I became curious about the possibility that the blinds were used as nesting sites by these big herons. All blinds are in shallow water, six inches to one foot deep and sometimes less with a low tide, and they cannot be approached closely by boats. After some searching, Johns and I found one where we could get within reasonable wading distance. Two parent birds flew away as we approached. The blind supported two nests, built on top. One was empty and the other contained two young birds, well-feathered out and about the size of their parents. They squatted down in the nest when approached. After a few moments we left.

Many other blinds with Great Blue Heron nests have been seen since then, and the use of duck blinds for nesting seems to be a common habit with this heron. Fortunately, the blinds are not easily approached by curious fishermen or predators from land. Thus, they would appear to be excellent nesting sites for all herons, but other species have not been seen using blinds for that purpose and it appears that the smaller species are more gregarious than the Great Blue Heron when it comes to nesting activity. A few thousand of these blinds spot the shallow bays of South Texas, and they are rebuilt every year. Thus it seems, that so long as the ducks and hunters last, Great Blue Herons will not suffer from lack of nesting space on the Texas coast.—GORDON GUNTER, *Gulf Coast Research Laboratory, Ocean Springs, Mississippi.*

On the Reluctance of Gulls to Fly under Objects.—The causeway between Aransas Pass and Port Aransas, Texas, is bordered by telephone wires and two sets of electric lines, the so-called high lines. Pelicans and herons will occasionally fly under these lines, but gulls seldom do, so far as my observation goes. In several other instances, I have noticed the reluctance of gulls to fly under objects, even when there was ample clearance. An outstanding example happened several years ago. I have held off recording it in the hope of repeating the observation, but the opportunity has not occurred and there is no reason to defer the account further.

After making a trawl station during an ecological study in Copano Bay, I cleaned the deck by throwing the fish and shrimp overboard to the gulls. It was my habit to throw the fish in the air for the gulls to catch. Quite a flock of Laughing Gulls (*Larus atricilla*) and a few Royal Terns (*Thalasseus maximus*) gathered and followed along behind the boat as it went down the bay.

Parenthetically, it should be noted here that I have engaged in this simple pastime many times during the past twenty-four years on the Louisiana and Texas coasts and the chief followers are always Laughing Gulls and a few Royal and Caspian

(*Hydroprogne caspia*) terns. The terns are much the more adept at catching fish in the air and can swoop in sideways, taking thrown fish on the run, so to speak. Conversely, gulls usually cannot catch a fish unless it is thrown straight at them, and even then they often misjudge the rate of fall and miss the catch. In their efforts they sometimes sprawl clumsily in the air with legs, as well as wings, outstretched, shrieking all the while. Young birds are not able to catch thrown fish under the best circumstances but they can be trained. Gulls following shrimp boats when the trash fish are being thrown overboard are common sights in these waters. They often fly close, ten to twenty feet overhead, and about the same distance behind the boat. The terns fly farther back and higher on the outskirts of the screeching flock. Thus it was in Copano Bay.

While I was busily engaged in feeding the gulls, the boat ran under the Copano Causeway, the mast having been removed for that purpose so that we would not have to wait for the drawbridge to be raised. I continued to throw the fish and waved at the gulls, but although the boat was in plain sight under the causeway, and was at first only a few feet away, the whole flock hung suspended where they were when the boat went under the drawbridge. They acted as if they could not see the boat at all and, to all intents and purposes, as if it had vanished into a solid wall. The birds remained suspended and stationary in that fashion, while the boat proceeded down the bay at about eight miles an hour. After it had gone two to three hundred yards, the elapsed time being 50 to 75 seconds, a tern flying higher than the gulls sighted the boat from above the causeway and came to it. The gulls saw the tern and streamed over the causeway to resume their feeding behind the boat which apparently had only reappeared to their view when they saw it from above the causeway.

Birds accustomed to flying in and out of trees are not loath to fly under overhead objects. The habitat and habits of gulls are quite different, and they are clearly reluctant to fly under overhead objects, even when there is ample leeway. The above observation suggests the possibility that gulls may have some mental occlusion which prevents them from seeing through or beyond overhead structures even though there are no physical obstructions to a clear view.—Gordon Gunter, *Gulf Coast Research Laboratory, Ocean Springs, Missississippi.*

Some Early Drawings of Canadian Birds.—A publication little known to ornithologists and deserving of a brief description is the following: Les Raretés des Indes: "Codex Canadensis," Librairie Maurice Chamonal, Paris (1930). In March, 1949, I saw the album of original drawings which has since been acquired by an unknown private collector. The first part of the title is that of the binder of the original album and the second part, "Codex Canadensis," was added when the drawings were reproduced. The album contains 56 drawings of birds, 67 of mammals, 18 of plants, 33 of fishes, and several of reptiles, batrachians, and insects.

The identity of the artist is not known with certainty. All that is known about him is contained in the brief preface to the reproduction by Baron Marc de Villiers. The quotations from uncited documents indicate that the artist was Charles Bécard de Granville, who was born in Quebec in 1675, and who died in that city on January 2, 1703. De Villiers inferred from the little documentary material available that the drawings were executed in 1701. De Granville is stated to have been the only person in Canada at the time capable of drawing a map. The artist was without formal training but showed sufficient talent that, to permit him to perfect himself in drawing, an annual gratuity was sought for him from Louis XIV. The coat of

arms of this monarch is stamped on the original album. De Villiers says: "il est fort probable" that de Granville sent the drawings to the King as an indication of his promise as an artist.

The drawings of the birds are so highly stylized that even with the legends, which sometimes carry the Indian names, it is impossible to identify many of the species. A somewhat similar problem of identification has occurred with the birds of Denys, although the latter's text lacked accompanying drawings (Nicolas Denys: "Description geographique et historique des costes de L'amerique Septentrionale, avec l'histoire naturelle du païs." Paris, 1672; English edition by W. F. Ganong, Toronto, 1908; see Elsa G. Allen, 'Auk,' 56: 283–290, 1939; Francis H. Allen, 'Auk,' 57: 75–82, 1940). The manuscript text that accompanied de Granville's drawings unfortunately was lost.

The Crossbill and Hummingbird offer no problem due to peculiarities of structure. The drawing of the 'American Sparrow' contains a fuller legend than usual. It reads: "American Sparrow, the plumage of which is highly variable. In winter it is entirely white. At other seasons it is gray, mixed with a diversity of colors." Presumably, this is the Snow Bunting (*Plectrophenax nivalis*).

The liberties taken in some of the drawings may have been deliberate, or due to an attempt to sketch from memory. The drawing of the Passenger Pigeon (*Ectopistes migratorius*), one of the earliest known, has the tail forked instead of cuneiform. The *Outarde* (*Branta canadensis*) has a white spot on the side of the head in place of the white band on the chin.

The "American Jay with entirely blue plumage" (*gey ameriquain du plumage tout bleu*) is undoubtedly the Blue Jay (*Cyanocitta cristata*) though only a slight crest is shown. Ganong (*op. cit.*) concludes with reason that Denys' *Gays* refer to gayly colored birds and not to jays. Jay (*geai*) in old French has been spelled variously *gai*, *jaie*, and *jai*. "Jay" appears to be of onomatopoeic origin and "gay" may have been derived from it.—A. W. Schorger, *University of Wisconsin, Madison.*

A Bibliographical Bonanza.—Daniel C. Haskell, retired bibliographer of the New York Public Library, had the good fortune to unearth some notebooks by editors of *The Nation* which identified the authors of thousands of unsigned articles and reviews in that periodical. The results have been published by the Library as: "The Nation, Volumes 1–105, New York, 1865–1917. Indexes of Titles and Contributors," Vol. I. Index of Titles (iv + 577 pp.); and Vol. II. Index of Contributors (iv + 539 pp.), 1951 and 1953, respectively. These are excellent sources of information about the writings of notables of the period covered, among them a number of ornithologists. Of the latter, those having ten or more entries include: J. A. Allen, 14; Spencer F. Baird, 10; William Beebe, 22; Elliott Coues, 65; Francis H. Herrick, 12; and Sylvester D. Judd, 52. The Coues items, as I have learned by a separate study, include eleven that were signed articles, and thus are available through ordinary bibliographic procedures. I was surprised by the Judd entries, as I knew him fairly well and never heard him or any of his friends allude to his writing for *The Nation*. These 52 reviews exceed by two and one-half times the entire number of publications I was able to cite for him in an obituary appearing in 1942 (The Auk, **59**, July, pp. 464–467). Ornithologists represented by fewer than ten titles in the indexes noted are: Francis H. Allen, Paul Bartsch, John Burroughs, Frank M. Chapman, Guy Emerson, Wilson Flagg, Helen M. Judd, Frederic A. Lucas, C. H. Merriam, Henry Oldys, and R. W. Shufeldt.—W. L. McAtee, *3 Davie Circle, Chapel Hill, North Carolina.*

Probable Breeding of the Northern Prairie Warbler (*Dendroica discolor discolor*) in Florida.—At the time of publication of *Florida Bird Life* (Howell, 1932), all Florida breeding specimens of the Prairie Warbler were assigned to the race, *D. d. collinsi*, the distribution of which was confined to the peninsular portion of the State. Specimens from as far north as Fernandina indicated that its range almost reached the Georgia line, although specimens from southeastern Georgia have been referred by Oberholser to *D. d. discolor* (*Birds of Georgia*, Greene, *et al.*, 1945) and *collinsi* apparently has never been taken in that State. In view of the fact that this part of the species' range is apparently continuous, the zone of intergradation of the two subspecies remains to be determined.

Farther west, the range of the Prairie Warbler is discontinuous. Howell mentioned no breeding stations north of Anclote Key and Micanopy, but more recently (April, 1949) I observed birds in full song and probably breeding at Cedar Key. From this latitude north to Cuthbert and Fitzgerald in central Georgia, the Prairie Warbler was unknown as a breeding bird through 1945 (Greene, *et al.*, *op. cit.*). On June 26, 1947, however, Robert Norris took a singing bird of the race, *discolor*, at Hilton, almost 40 miles south-southwest of Cuthbert (Norris, *Distribution and populations of summer birds in southwestern Georgia*, 1951). Through verbal communication with Herbert L. Stoddard, I learned that Prairie Warblers were found nesting in southern Grady County, Georgia, in the summer of 1952, presumably bringing the breeding range of the northern race within a few miles of Florida.

This range extension suggested the possibility that the race, *discolor*, might soon nest in Florida, and in the following year (1953) one was found in full song apparently on its breeding grounds about 12 miles north of Tallahassee in April and May. On June 4, when I set out to collect this individual, it could not be located, but several miles farther north, just one-half mile from the Georgia State line, another singing male was located and secured in typical breeding habitat of scrubby oaks (*Quercus marylandica*) mixed with pines. These circumstances, along with the well developed condition of the testes, left little doubt that it was on its breeding grounds, although no female or nest was found. My gratitude is extended to Stoddard, who prepared the skin and presented it to Florida State University; also to Allen Duvall, of the U. S. National Museum, for verifying the fact that the specimen was an example of the Northern Prairie Warbler (*D. d. discolor*).

It is extremely unlikely that a species with so distinctive a song could have been overlooked by the many ornithologists who have worked in Grady County, Georgia, and Leon County, Florida; a southward range extension is far more probable.—HENRY M. STEVENSON, *Department of Zoology, Florida State University, Tallahassee, Florida.*

Unusual Behavior of a Pied-billed Grebe (*Podilymbus podiceps*).—On October 3, 1954, I was astounded to see a young Pied-billed Grebe diving in our small swimming-pool in competition with several shrieking children. The children caught the grebe when it came up on land. When the bird was placed back in the water it eyed us steadily and, with the motion of an ice-skater skating slowly backwards, retreated a few feet to deeper water and then, with a sudden turn-about, plunged beneath the surface. It reappeared at the other end of the pool where it remained until left in peace.

A young grebe, presumably the same individual, was reported sporting in a neighboring swimming-pool a few days later!—ROBERT M. LAUGHLIN, *Drake's Corner Road, Princeton, New Jersey.*

Status of the Upland Plover in Lancaster County, Pennsylvania.—The census report of 1954 on *Bartramia longicauda* in Lancaster County, Pennsylvania, follows the plan of earlier reports (Auk, **43**: 93–94, 1926; **53**: 443–444, 1936; **57**: 110, 1940; **59**: 108–109, 1942; **63**: 92–93, 1946; and **66**: 202–204, 1949). The count was made on the four tracts which, prior to 1914, had been the author's choice plover-shooting grounds. None of these tracts, with the exception of B, which has been improved by being now continually in grass, has changed in buildings and other encroachments on the prairie-like lands which are the only grounds the plover ranged when it adopted Lancaster County's cleared farmlands, presumably about 1800.

In 1900, according to the author's Diary of Field-Sports, each of these tracts would have shown, at times, numbers of plover varying between 20 and 300. Had the count been taken in that year the total would have been between 500 and 700. Central and northern Lancaster County seem to be one of the bird's favorite breeding grounds since the plover came into the Piedmont Plateau of southeastern Pennsylvania, which is the only part of the hilly and woody state extensively used by it.

Coming into Lancaster County about April 15, and leaving for its winter home, chiefly in Argentina, about the last week in August, the plover is most numerous here about August 1.

Since the last census report in 'The Auk,' April, 1949 new light has come on the plover's migration route. M. G. Vaiden, of Rosedale, northwestern Mississippi, reports that beginning in late July and continuing through August until about September 10, Upland Plovers move through Mississippi and over the Delta in large numbers. In the spring, though not as plentiful as in late summer, they are fairly common migrants in northwestern Mississippi. Thus the route as now known is northward through Texas, Oklahoma, and probably western Mississippi; and southward over the Delta of the Mississippi, through the eastern islands of the Caribbean into the pampas of South America. The widely separated tracts, in central and northern Lancaster County, where the count was made, are: A, two square miles in Penn and Warwick townships; B, two square miles in Manheim Township, including the Lancaster Municipal Airport; C, one square mile in Warwick Township; D, two square miles in Elizabeth and Clay townships.

The complete census report, to date, is as follows:

	Tract A	*Tract B*	*Tract C*	*Tract D*	*Total*
1921 (August 4)	12	3	3	3	21
1922 (August 3)	8	9	1	4	22
1923 (August 9)	23	35	1	15	74
1925 (August 8)	1	3	0	1	5
1936 (August 4)	5	22	4	11	42
1937 (August 4)	11	28	1	17	57
1939 (August 3)	14	75	0	5	94
1941 (August 4)	94	65	0	2	161
1945 (August 8)	5	28	12	2	47
1947 (August 6)	23	82	1	2	108
1954 (August 2)	16	140	0	0	156

The count of 1945, I do not consider normal. That season haymaking and harvest were so delayed by nearly continuous wet weather that the first week in August

found most of the grass and wheat fields still uncut and full of weeds. Feeding conditions being unfavorable, I believe many of the plover left the region earlier than usual.

In 1947, the largest count (82) was on tract B, the Lancaster Municipal Airport, which had been put there a few years before. Within Lancaster County, the plover gather at the Airport, as a breeding and feeding ground, in the largest numbers. The birds, still wary of man, ignore rising and descending planes on the Airport. Tract D, where on July 16, 1906, there were 250 to 300 plover (Diary of Field-Sports), since 1937 has been practically without them.

Assuming that the census in Lancaster County represents conditions elsewhere in the bird's extensive breeding range in North America, the general numerical status of the Upland Plover seems to be stabilized today. While there has been a notable increase since 1914 (when the bird was removed from the game-list), the rate of production in the northern zone seems to be balanced by the rate of destruction in the southern zone. While the census of 1954 shows an encouraging increase, the Upland Plover is still being shot in large numbers along its migration route, as on the Barbados, where Richard H. Pough recently found it being murdered in the fall. Nor has there been any change in reports from the bird's winter home, where, in 1926, Alexander Wetmore found the Upland Plover to be the favorite game-bird of the sportsmen and many market hunters; the choice morsel of the Argentina restaurants.

A perpetual closed season on the Upland Plover in the United States has undoubtedly saved the species from going the unhappy way of its late cousin, the Eskimo Curlew (*Numenius borealis*). But who is to stop the killing of this tempting morsel along its 14,000-mile migration route and on the vast pampas of South America?

I was assisted in taking the census of 1954 by James P. Coho, Barton L. Sharp, and Milton G. Steffy.

HERBERT H. BECK, *Franklin and Marshall College, Lancaster, Pennsylvania.*

Pleistocene Birds from Eichelberger Cave, Florida.—Eichelberger Cave is located about two miles southwest of Belleview, Marion County, Florida, in the northwest corner of Sec. 2, T.17S., R.22E. Vertebrate fossils occur in several feet of sandy matrix at two localities in the cave. Locality A lies about 350 to 370 feet from the entrance. It was investigated by Robert Cumming on October 5, 1952, and on June 6, 1953. Locality B is about 26 feet from the entrance. It was excavated by Walter Auffenberg on December 27, 1954. The Pleistocene age of these deposits is indicated by the presence of an extinct turtle of the genus *Testudo* at both localities and by six extinct species of mammals at Locality B. Nine bird bones, representing five species, have been recovered from the cave. They all represent species still living in the area today. Three of the five species have not previously been recorded as fossils.

Colinus virginianus (Linnaeus). Bob-white.—Locality A: left humerus, left femur (juvenile), left tibiotarsus, left tarsometatarsus. The Bob-white has been reported previously from the Pleistocene of Florida and Tennessee (Wetmore, 1931, Smiths. Misc. Coll., 85: 32).

Philohela minor (Gmelin). American Woodcock.—Locality B: left tibiotarsus. Previously unrecorded as a fossil.

Strix varia Barton. Barred Owl.—Locality B: left tarsometatarsus. Reported from the Pleistocene at three Florida localities (Wetmore, *op. cit.:* 40).

Colaptes auratus (Linnaeus). Yellow-shafted Flicker.—Locality B: right humerus. This species was unreported in a fossil state.

Sturnella magna (Linnaeus). Eastern Meadowlark.—Locality B: right coracoid, right humerus. Hitherto unrecorded as a fossil.—PIERCE BRODKORB, *Department of Biology, University of Florida, Gainesville.*

Two Albinistic Alder Flycatchers at Ann Arbor, Michigan.—There are few published records of albinism in the family Tyrannidae. Ruthven Deane recorded two: a Kingbird ("*Tyrannus Carolinensis*" = *T. tyrannus*), the only example in the family he had "ever heard of" (1876), and later (1879) a "perfect albino" Wood Pewee (*Contopus virens*) reported to him in a letter (Bull. Nuttall Ornith. Club, **1**: 22; **4**: 29). Kenneth Gordon (Auk, **45**: 101, 1928) collected an albino Kingbird whose body plumage was "snow white"; wing and tail feathers "pale lemon yellow, with white shafts"; eye "dark as in a normal bird." D. R. Hostetter (Auk, **51**: 524, 1934) described a nestling Phoebe (*Sayornis phoebe*) with wing and tail feathers "cream throughout"; contour feathers "gray beneath, but tipped with cream"; eye normal. The Phoebe's four nest mates were normal.

P. A. Taverner (Auk, **48**: 603, 1931) described a partial albino Alder Flycatcher (*Empidonax traillii*) as follows: "The bird is all pale lemon yellow (Martius to Picric Yellow of Ridgway's 'Nomenclature'), whitening to throat, except for a saddle of normal dark olive across the shoulders extending from up the back of the neck to near rump."

During the years 1948 through June 1954, I recorded 308 young Alder Flycatchers (nestlings or young which had just left the nest) in the vicinity of Ann Arbor, Michigan. In none of these was there any indication of albinism. Similarly, Walter Nickell of Cranbrook Institute of Science (letter, August 23, 1954) has recorded "at least 600" young Alders during the last 15 years in the nearby Bloomfield Hills area. He has never seen an albino, either partial or complete.

On July 4, 1954, near Dixboro, Michigan, I found an Alder Flycatcher nest with four eggs. On July 13, the nest contained four young about 6 days old. Two of the nestlings were normal examples of the species with pale olive-brown natal down. In the other two, the skin was paler, the down a pale yellow, the furled juvenal feathers appearing through the sheaths a deeper yellow. On July 19, I took the larger of the two albinos (estimated to be 12 days old) to raise it in captivity. On the following day as I approached the nest, the larger of the two normal-plumaged birds flew off some 50 feet and alighted about 20 feet from the ground in a tree. I captured the bird, hoping to raise it with the albino, but it died on July 25.

The other albino and the smaller of the two normal birds left the nest on July 21, before 8:00 P.M. I saw the normal bird near the nest but could not follow it because of the poor light. At 7:00 A.M. on July 22, the two birds were perched side by side on a branch 6 feet from the ground and 25 feet from the nest. As I approached, both birds flew off, in different directions, the albino flying about 100 feet and alighting 25 feet from the ground in a large tree. It was not possible to catch either of them. On July 27, the two banded young and the adults were in a *Crataegus-Prunus* thicket about 50 feet from the nest. I saw the albino again in the general vicinity of the nest on August 5, but I did not find it on August 11 or August 17.

I raised the captive albino in a screened breezeway (except from August 19 to 27) from July 19 to September 22. On the latter date, a study skin (U.M.M.Z. No. 135,857) was made. The bird, a female, weighed 12.1 grams. The skull was *completely ossified*. There are no dark feathers. With the exception of yellow, there is an apparent failure of all color factors that are expressed in the normal bird. The yellow (in north light on a clear day) is somewhat paler than Ridgway's Martius Yellow cited in Taverner's description above and is perhaps better matched

by Naphthalene Yellow. In Ridgway's system, both these shades have the same color value; Naphthalene Yellow has, however, 32 per cent neutral gray, whereas Martius Yellow is "pure." In shadow the bird might be described as cream or ivory. The concealed bases of the feathers (slate-gray in normal birds) are pure white. The chin and throat (whitish to pure white in normals) are white, with an almost imperceptible trace of yellow at some of the tips. The back shows very faintly as a negative of the normal pattern, being more white where the normal is more black—crown, tail feathers, primaries, alula. The buff wing bands of the normal bird are very faintly traced in slightly deeper yellow. Feather shafts (blackish brown in normal) are white. In life, the eye-color (red-brown) of the albino was indistinguishable from that of its normal fellow-captive. Bill and feet, however, were pale pinkish in contrast with the normal bird's brownish black.

On August 1, 1954, I had taken a normal-plumaged bird (estimated to be 13 days old) from a nest near Ann Arbor. This bird was raised with the albino until September 22, on which date a study skin (U.M.M.Z. No. 135,858) was prepared. This bird, a male, weighed 14.5 grams; the skull was not completely ossified.

Both birds had become independent in obtaining food when about 26 to 27 days old (August 3 and August 13, respectively, for the albino and the normal-plumaged bird). They would, however, take food held in forceps when flying insects were not provided in adequate numbers. Until August 17, the two birds usually perched side by side during the day and invariably did so at night. During my absence from Ann Arbor, August 19 to 27, the two birds were caged at the University of Michigan Museum of Zoology, where Dr. J. Van Tyne made further observations. It was during this period that the normal bird began to exhibit dominant behavior over the albino. When the birds were released on the breezeway again (August 28), the normal bird had precedence in selecting perches, was first to fly to the re-filled food dish, frequently took food away from the albino (earlier, August 16 and 17, the albino attempted to take food from the normal bird and sometimes succeeded), and spent much time chasing her. On several occasions, the albino was observed to crouch and slightly spread her wings while perched below the normal bird. The birds no longer perched together at night.

It is impossible to say how much of the difference in behavior was to be attributed to sexual differences and how much to the albinism of the female.—Andrew J. Berger, *Department of Anatomy, University of Michigan Medical School, Ann Arbor.*

Streptoprocne semicollaris **in the lowlands of Sinaloa and Nayarit.**—We saw this little-known swift on at least two occasions in flocks observed over the coastal lowlands of Sinaloa and Nayarit in early May.

The first time that we saw a flock of large swifts in Sinaloa, May 8, 1954, we were on the highway 20 miles north of Mazatlán. This widely scattered flock contained about 10 individuals, some of which were tentatively identified as *semicollaris.*

Several individuals were positively identified as this species in a flock of about 20 birds observed on May 11, 1954, as they moved erratically near the highway 44 miles south of Mazatlán. There was no indication that the flock included any other species.

On May 13, 1954, a loose flock of 20 to 30 swifts, apparently all *semicollaris,* flew generally southward over our camp near the highway six miles south of Acaponeta, Nayarit (and 103 miles south of Mazatlán). A few moments later Hilton secured one of the swifts as it flew over a field a half mile south of camp

The bird was a female *semicollaris* with an ovary four millimeters long, and it had a small amount of fat. Feather arrangement and colors of the soft parts were recorded in a partial field sketch by Hilton. The specimen, a first record for the state of Nayarit, is now in the collection of Dr. George M. Sutton at the University of Oklahoma.

Possibly the three different observations may have involved only one loose flock, if we can assume such a flock to have been moving slowly and steadily southward over the Pacific coastal plain.

We could not detect any well-marked differences between the behavior of this species and that of *Streptoprocne zonaris*.—ERNEST P. EDWARDS, *Box 611, Amherst, Virginia, and* FREDERICK K. HILTON, *Division of Vertebrate Ecology, The Johns Hopkins School of Hygiene and Public Health, Baltimore, Maryland.*

The Scientific Name of the Florida Prairie Warbler.—In the January, 1930, *Auk* (published January 2) Arthur H. Howell described (p. 41) the very well-marked geographical form of Prairie Warbler which inhabits Florida, naming it *Dendroica discolor paludicola*. However, shortly after that, ornithologists discovered that there was another name, *collinsi*, proposed by Harold H. Bailey in a privately published leaflet, "The Bailey Museum of Natural History Bulletin No. 3." At the close of "Bulletin 3" appear the figures "11-16-1926," and ornithologists hastily assumed that this demonstrated the public distribution of the pamphlet on or about November 16, 1926. Perhaps the 1926 date represents the date of completion of the manuscript—a matter which has no bearing on nomenclature. A careful investigation by Dr. Walter Koelz and myself disclosed no evidence that any copy of Bulletin 3 was received by any institution or individual ornithologist earlier than February 10, 1930; most dates of receipt were in March, April, or May, 1930. I wrote to Mr. Bailey for assistance and from his reply I judge that he does not make any claim for the priority of the name he proposed.

Therefore I conclude that the Florida Prairie Warbler must be known as *Dendroica discolor paludicola*.—JOSSELYN VAN TYNE, *University of Michigan Museum of Zoology, Ann Arbor.*

First Revisor of the Eastern Sapsuckers.—"Now why cannot we allow the type locality to stand at the rather indefinite statement 'Carolina' just as he [Catesby] left it and follow the first revisor of the species as to whether the Catesbian bird represents the northern or southern race? Why make a positively definite statement which the evidence does not warrant and which overturns the good work of our predecessors?" Thus wrote Witmer Stone in 1929 (Auk, **46**: 453).

What prompts this reiteration of Stone's good advice is Ganier's renaming the southern Appalachian Sapsucker (Migrant, **25**: 40, 1954). Ganier points out that Oberholser in 1938 used *S. v. varius* Linnaeus (ex Catesby) for this bird and *S. v. atrothorax* Lesson for the more northern bird.

On debatable technicalities, and quoting an earlier part of Stone's paper mentioned above as though supporting his views, but ignoring Stone's considered opinion, Ganier overthrows the first revisor, Oberholser, who unearthed an earlier name, and coins a new name!

Threshing the old straw of nomenclatural discussions, where opinion rather than fact must rule, the first revisor's principle offers stability of a sort. Oberholser's first revision, which can be defended on every point, should stand for purposes of nomenclature, if not for those of taxonomy.—A. L. RAND, *Chicago Natural History Museum.*

REVIEWS

A Guide to the Birds of Ceylon.—G. M. Henry. London: Oxford University Press. xl + 432 pp., 30 pls. 124 drawings, end-paper map. Price $6.55.—G. M. Henry is well-known as a bird artist through his illustrations for various bird books, including one on hill birds of India by Salim Ali. Between 1927 and 1935, the Ceylon Government published a beautiful series, "Coloured Plates of the Birds of Ceylon" by Mr. Henry, and now his son, David Reid-Henry is following in his father's footsteps, a notable succession in a talented family.

G. M. Henry is well qualified to write on the birds of Ceylon as he lived on the Island for many years prior to World War II, finally retiring in the late 1940's to a village in Oxford where he now lives. The book imparts a certain feeling of nostalgia for the days when the author lived in a tropical paradise for a lover of nature. The main attraction of the book is the series of superb illustrations done with great competence by the author. He and his son are excellent bird illustrators, certainly as good as any now living. The black and white drawings are perfect, and my only criticism of the colored illustrations, which are obviously excellent as originals, is that the color reproduction is not perfect, and the plates suffer somewhat thereby, through no fault in the least of the author. The blue and green tones are occasionally much too weak or again much too strong, while the yellows and the reds are in general good.

The book opens with general comments about the development of ornithology in Ceylon and hints for bird watching on the Island. It is perhaps too bad that more is not said about the present status, as my impression is that there is now a very active interest in birds on the Island, partly through the activity of societies and journals such as "Loris," none of which are mentioned. There is a section on topography and climate which is rather superficial, including a statement that in its geological history Ceylon has been "severed" from the mainland and "drifted eastwards" to form a separate island, and that the southern mountainous half of the Island has been severed from the parent continent for a vastly longer period of time than the northern portion. This seems gibberish to me; and even if it be true, it can hardly have had much effect on the evolution of the birds, as the author assumes, because any such major crustal movement must have occurred long before birds as we know them were in existence.

Following this, there is a discussion of nomenclature and a technical list of the families, genera, and species of birds found in Ceylon. Mr. Henry refers to a recent major revisionary publication by W. W. A. Phillips who published in 1952 a revised checklist of the birds of Ceylon, but most unfortunately he does not adopt Phillips' arrangement or classification. He states that his book is not intended as a work on classification or nomenclature, but rather as a help towards "enjoying the birds," and therefore, the precise arrangement is not of very great importance; he does not think the student will find much difficulty in correlating the "Guide" with the "Checklist." Following this statement, Mr. Henry goes on blithely listing all the technical names for the species as if he thought it were important, and adopting a higgledy-piggledy arrangement, sometimes following earlier authors such as Wait, sometimes later ones such as Whistler or Phillips, all in a way which is likely to confuse any student. This is the sort of a book which, in its technical treatment is likely to convince the amateur that nomenclature is a farce and something on which no one can agree, and its practitioners are all blatherskites.

The rest of the book is devoted to a list, species by species, of the birds of Ceylon. Aside from the questionable technical arrangement, the information contained

in this section is well-presented and interesting reading. There is a good deal of new information as well. Mr. Henry includes sight records of forms not previously recorded, and he has a good deal to say about distribution, and in many cases, about habits, calls, field observations, all matters of great interest and use. In some cases he lists species only as species, in others he gives separate sections for subspecies, again a matter on which he seems not to be clear. In one or two cases he questions existing subspecies on the grounds that the populations concerned are not resident, an assumption which seems unsupported by the evidence. Comments such as these of the author certainly result from a lack of interest in technical matters such as speciation and would much better have been left out either by the author, or by whomever the editors of the Oxford University Press consulted in connection with its publication.

In general, it seems to me this book serves as a reminiscent and happy memory of Mr. Henry's many years in Ceylon, with a host of interesting notes on various bird species and a splendid series of illustrations. As such and as such alone this volume can be a useful guide to getting to know birds in this fascinating part of the world.—S. Dillon Ripley.

Records of Birds of Prey Bred in Captivity.—Arthur A. Prestwich, London, N. 14, 61 Chase Road (published by the author) 31 pp., 1955. This is the second edition, the first one having been published in 1950. The present list has been brought up to date and several old records, previously overlooked, have been brought to light. Many important observations on the life habits of birds of prey are reported in the present volume, which includes the falconiforms as well as the owls. It is interesting to note that the Andean Condor has been one of the most prolific birds of prey in zoos despite the fact that it lays but a single egg which takes almost two months to hatch. Some other vultures and owls also nest fairly readily. Hawks, eagles, and falcons are not so easily induced to breed in confinement.—J. Delacour.

RECENT LITERATURE

EDITED BY FRANK McKINNEY

Anatomy and Embryology

Berger A. J. 1955. Notes on the myology of the Great Curassow [*Crax rubra*]. Wilson Bull., **67:** 136–138.

Brodkorb, P. 1955. Number of feathers and weights of various systems in a Bald Eagle [*Haliaeetus leucocephalus*]. Wilson Bull., **67:** 142.

Brooks, J., and H. P. **Hale.** 1955. Strength of the shell of the hen's egg. Nature, **175** (4463): 848–49.

Cole, W. V. 1955. The comparative morphology of sensory endings in striated muscle. Trans. Am. Micros. Soc., **74** (3): 302–311.—Includes the pigeon [*Ectopistes migratorius*!] and the fowl.

Kuroda, N. 1955. Additional notes on the osteology of the Alcidae (Aves). Annot. Zool. Jap., **28:** 110–113.—*Fratercula, Lunda, Cerorhinca,* and *Cyclorrhynchus* discussed.

Norris, R. A., and F. S. L. **Williamson.** 1955. Variation in relative heart size of certain passerines with increase in altitude. Wilson Bull., **67:** 78–83, 1 fig., 1 tab.—In each of 12 species of passerine birds the heart/weight ratio was higher in birds from high elevations than in those from low elevations.

Olsen, M. W., and S. J. **Marsden.** 1954. Natural parthenogenesis in Turkey eggs. Science, **120** (3118): 545–546.—Incubated, unfertilized, eggs of virgin Beltsville White Turkeys developed embryos in from 14.1 to 22.4 per cent of the eggs in a series of three tests involving 4934 eggs. The most advanced embryos attained a stage equivalent to that reached in normal turkey embryos at 26 to 27 days.

Saunders, J. W., and M. T. **Gasseling.** 1955. Effect of implantation site on the development of an implant in the chick embryo. Nature, **175** (4459): 673–74.

Yao, T. S., and M. W. **Olsen.** 1955. Microscopic observations of parthenogenetic embryonic tissues. Journal of Heredity, **46** (3): 133–134.—Eggs from virgin female Turkeys showed embryonic development upon being incubated. Most development consisted solely of embryonic membranes but a few formed embryos occurred. The embryonic cells were mostly diploid and underwent normal mitosis. It is assumed that the single egg cell doubled the chromosome number at an early stage.

Behavior

Brewer, R. 1955. Size of home range in eight bird species in a southern Illinois swamp-thicket. Wilson Bull., **67:** 140–141.

Courson, F. M., **Jr.** 1955. Peculiar Red-breasted Nuthatch behavior. Bull. Me. Aud. Soc. **11:** 10.—Bird landed on author's shoulder, then wrist, front of sweater, and rim of glasses. Appeared normal and quite unafraid.—L. M. Bartlett.

Dzubin, A. 1955. Some evidences of home range in waterfowl. 1955. Trans. 20th N. A. Wildlife Conf., pp. 278–298.—Home range during the breeding season was approximately 1300+ acres for the Canvasback, 700+ acres for the Mallard, and 250+ acres for the Blue-winged Teal. "Territory" was the defended 3 feet around Canvasback females, and an ameboid-shaped area in the other two usually including one or more waiting places as well as the defended area around the female. In the two dabblers, territorial pursuit is directed against the female of the transgressing pair.

FRINGS, H., M. FRINGS, B. COX, and L. PEISSNER. 1955. Recorded calls of Herring Gulls (*Larus argentatus*) as repellants and attractants. Science, **121** (3140): 340–341.—A recording of the alarm call broadcast over a period of one minute cleared 300 gulls from a regular feeding area for periods of from 10 minutes to about 3½ hours. It is stated that the biological significance of the call gives it power far beyond that conferred merely by high intensity. A food-finding call recording proved highly attractive to these gulls.

LAWRENCE, L. DE K. 1954. Irrepressible Nuthatch. Audubon Mag. **56**: 264–267.—Careful observations throughout one year of several color-banded individuals in Ontario. Original accounts of pair-formation and breeding behavior in *Sitta canadensis*. The pair observed raised two broods in one season.

PASTORE, N. 1955. Learning in the Canary. Scientific American, **192** (6): 72–79. —Canaries were found able to respond to perceptual and spacial relationships and capable of insightful or conceptual behavior in the experiments where they had to respond properly to various configurations of objects or move objects to obtain a standard food reward. Pastore concludes either that the brain cortex of a bird is capable of more complex performances than has generally been conceded or that its subcortical centers can carry on complex activities usually assigned to the cortex.

SIBLEY, C. G. 1955. Behavioral mimicry in the titmice (Paridae) and certain other birds. Wilson Bull., **67**: 128–132.—Incubating adult titmice and nestling titmice of several species, and some hole-nesting birds of other families, perform a snake-like hissing and lunging when disturbed in the nest. The author believes this display to be protective mimicry.—J. T. Tanner.

STILLWELL, J. E., and N. J. STILLWELL. 1955. Notes on the songs of Lark Buntings. Wilson Bull., **67**: 138–139.—*Calamospiza melanocorys*, studied by recordings.

TINBERGEN, N. 1954. The courtship of animals. Scientific American, **191** (5): 42–46.—A popular account in which the courtship behavior of the Black-headed Gull is used as an example.

TORDOFF, H. B. 1955. Food-storing in the Sparrow Hawk. Wilson Bull., **67**: 139–140.—Food was hidden by captive and wild *Falco sparverius*.

DISEASES AND PARASITES

BELL, J. F., G. W. SCIPLE, and A. A. HUBERT. 1955. A microenvironment concept of the epizoology of avian botulism. Journ. Wildl. Mgt., **19**: 352–357.—A new explanation of the culture medium of *Clostridium botulinum* Type C holds that the bacterium will germinate, reproduce and synthesize its toxin in small discrete particulate substances such as invertebrate carcasses. Confirmatory work in the laboratory is reported.

HERMAN, C. M., J. H. STEENIS, and E. E. WEHR. 1955. Causes of winter losses among Canada Geese. Trans. 20th N. A. Wildl. Conf., pp. 161–165.—In North Carolina, gizzard worms and nutritional factors seem to be important elements involving the loss of several hundred birds.

HUNGERFORD, G. R. 1955. A preliminary evaluation of quail malaria in southern Arizona in relation to habitat and quail mortality. Trans. 20th N. A. Wildl. Conf., pp. 209–219.—*Haemoproteus lophortyx* was widely prevalent among Gambel's Quail, much less so among Scaled Quail. The major vector, the louse fly *Stilbometopa impressa*, was encountered throughout the year on both species. No apparent relationship between rate of survival and degree of infection was detected in a one-year period.

McClure, H. E., and R. Cedeno. 1955. Techniques for taking blood samples from living birds. Journ. Wildl. Mgt., **19**: 477–478.—Jugular vein found best by experience; size of needle or syringe depends upon size of bird and research needs. Heparin is used to prevent coagulation in the instrument.

Neff, J. A. 1955. Outbreak of Aspergillosis in Mallards. Journ. Wildl. Mgt., **19**: 415–416.—Losses exceeding 1,000 birds occurred when bitter winter weather in Colorado forced the birds to feed on rotten, moldy ensilage that had been scattered by a farmer on top of the snow.

Rosen, M. N., and W. J. Mathey, Jr. 1955. Some new pheasant diseases in California. Trans. 20th N. A. Wildl. Conf., pp. 220–228.—Avian encephalomyelitis, spirochaetosis, Asiatic Newcastle, botulism, and visceral lymphomatosis have been observed. Game-farm releases can widely distribute diseases to wild populations. Introduction of exotic game birds can serve as a dangerous means of disseminating virulent diseases. Scavengers and cover can mask the mortality from disease in the wild.

Saunders, D. C. 1955. The classification of microfilariae in birds. *Avifilaris tyrannidarum* and *A. fringillidarum*, two new species. Trans. Amer. Micro. Soc., **74** (1): 37–45.

Webster, J. D. 1955. Three new forms of *Aploparaksis* (Cestoda: Hymenolepididae). Trans. Amer. Micro. Soc., **74** (1): 45–51.—From Red-backed Sandpiper and Varied Thrush.

Distribution

Allen, R. P. 1954. Comments on the status of the Flamingo in Florida. Everglades Nat. Hist., **2**: 115–118.

Baker, E. J., and H. E. Spencer, Jr. 1955. The winter waterfowl inventory in Maine. Bull. Me. Aud. Soc., **11**: 22–24, illus. Aerial census of 7 areas and ground census of 1 area reveal increase in Bufflehead and Scaup from 1952–1955 but more or less stable populations of Black Ducks and Golden-eyes.—L. M. Bartlett.

Bond, J. 1953. Additional notes on Blackpoll Warblers. Bull. Me. Aud. Soc., **9**: 34–35.—Coastal populations extend to the east side of St. Margaret Bay, Nova Scotia; on Grand Manan from Whale Cove to Long Pond; and on Gaspé to extreme eastern end. None were located on Prince Edward Island and in New Brunswick. A general withdrawal of boreal spp. from coastal lowlands is noted.—L. M. Bartlett.

Bourne, W. R. P. 1955. The birds of the Cape Verde Islands. Ibis, **97**: 508–556.—A detailed account of the forty species of birds occurring on the islands. Special emphasis is given the ecology of breeding seasons and clutch-sizes. Land birds breed during the rainy season, in August, September, and October. Sea birds breed early in the year, apparently in response to increases in food supply off the African coast. Clutch-sizes are small. Foraging behavior, voice and plumages, and habitat preferences are also discussed; patterns here may differ clearly from those of mainland birds; some Portuguese species, however, are similar.—R. F. Johnston.

Dane, N., II. 1954. Christmas bird count. Bull. Me. Aud. Soc., **10**: 2–7.—Over 100 observers in 31 census areas compiled a list of 93 spp. in spite of generally poor weather. A list of species and numbers is given, together with a list of participants.—L. M. Bartlett.

Day, R. L. 1953. The geographic distribution of wildlife in Maine. Bull. Me. Aud. Soc., **9**: 54–62.—Ten habitat regions in the State are described and characteristic wildlife noted. Changes in the bird, mammal, and cold-blooded ver-

tebrate populations are related to changes in land use. Although 16 spp. have been eradicated, an equal number of new spp. have been added. In general, populations remain steady.—L. M. Bartlett.

GROSS, A. O. 1955. A visit to the Camargue. Bull. Me. Aud. Soc., **11**: 38–42, illus.—Narrative of a 12-day visit.—L. M. Bartlett.

GUICHARD, K. M. 1955. The birds of Fezzan and Tibesti. Ibis, **97**: 393–424.—Annotated list of birds of the central Sahara, with extended remarks on migration and a zoogeographic discussion.

MATEU, J. 1949. Algo sobre la fauna de la Guinea Española. Archivos del Instituto de Estudios Africanos **3**, No. 8, pp. 93–107. A rambling description of the fauna of Spanish Guinea. The account of the birds runs from p. 101 to p. 104, and refers by scientific name to only 18 species in all, but these are merely cited as samples of a larger avifauna. The names, unfortunately, are incorrectly spelled in many cases, and practically no information is given about the individual species.—H. Friedmann.

MORRISON, J. P. E. 1954. Notes on the Birds of Raroia. Part 2 of Animal Ecology of Raroia Atoll, Tuamotus. Atoll Research Bulletin no. 34, Pacific Science Board, National Research Council, Washington, D. C., November 30, 1954, pp. 19–26.—This paper, issued in mimeographed form, lists 18 kinds of birds, all but two of which are water birds, as might be expected of a small southern Pacific atoll. Of the two land birds, one is a winter visitor, the New Zealand Long-tailed Cuckoo, *Urodynamis taitensis*, while the other, the Tuamotuan Warbler, *Conopoderas atypha atypha* is the only resident breeding land bird. The author classifies the water birds in three ecological groups:—sea birds that feed at sea and roost on the atoll, sea birds that feed in the shallow waters of the atoll, and shore birds that feed on exposed reefs and shores.—H. Friedmann.

PACKARD, C. M. 1953. Evening Grosbeaks summering in Maine and New Brunswick. Bull. Me. Aud. Soc., **9**: 7–13.—A summary of records plotted on a map. The relation of breeding sites to water and to areas of recent spruce-budworm outbreaks is noted. Range extension appears to be in rapid progress.—L. M. Bartlett.

PHILIPPI B., R. A., A. W. JOHNSON, J. D. GOODALL, and F. BEHN. 1954. Notes sobre Aves de Magallanes y Tierra del Fuego. Bol. Mus. Nac. Hist. Nat., **26**: (3), 53 pp., 8 figs.—Annotated list of 127 forms.

RICHARDS, T. 1954. A list of the birds of New Hampshire. N. H. Bird News, **7** (4): 3–10; **8** (1): 13–21.—The first and second of a series of proposed articles which will eventually complete an anotated list of the 330 spp. known to occur in New Hampshire.

RICHARDS, T. 1955. Changes in New Hampshire bird life. Part II. 1900–1955. N. H. Bird News, **8**: 43–52.—General trends in protection and subsequent increases of game birds during past 50 years are summarized. There follows a more detailed description of water birds, shorebirds, herons and egrets, and of the gulls, terns, and auks.—L. M. Bartlett.

SERLE, W. 1955. The bird-life of the Angolan littoral. Ibis, **97**: 425–431.

SQUIRES, W. A. 1955. The Clapper Rail in New Brunswick and Maine. Bull. Me. Aud. Soc., **11**: 2–3.—Six records from Maine and four from New Brunswick are examined. Author suggests the possibility of a breeding colony in N. B.—L. M. Bartlett.

TABER, W. 1953. Winter status of the Bonaparte's Gull in Maine. Bull. Me. Aud. Soc., **9**: 35–36.—Six new records (1938–1953) and 5 other published records (1945–1953) indicate a probable "regular but local" status.—L. M. Bartlett.

TAYLOR, LADY. 1955. Introduction to the birds of Jamaica. London, Macmillan and Co. Ltd. xiv + 114 pp.—Arranged by habitat, i.e. birds of the countryside, birds of lawns and gardens, birds of the upper air, etc. Field marks, status in Jamaica, and habits are discussed briefly. Most of the birds are illustrated by small black and white sketches.

WERNER, I. A. 1953. Present status of the Purple Martin in Maine. Bull. Me. Aud. Soc., **9**: 80–82.—Abundance fluctuates widely from year to year. Lack of sufficient insect food and cold wet weather during nesting may account for the fluctuations.—L. M. Bartlett.

ECOLOGY AND POPULATION

DALE, F. H. 1955. The role of calcium in reproduction of the Ring-necked Pheasant. Journ. Wildl. Mgt., **19**: 325–331.—No environmental factor, other than the presence of calcium, seems to explain the high population of pheasants in a limestone valley in Lancaster County, Pennsylvania, and the scarcity in a nearby noncalcareous area. Granite grit hinders reproduction under experimental conditions. A scarcity of calcium under natural conditions may explain the failure of this species in many parts of North America.

DUNNET, G. M. 1955. The breeding of the Starling *Sturnus vulgaris* in relation to its food supply. Ibis, **97**: 619–662.—This important study, made near Aberdeen, Scotland, examines some relationships between a breeding population of Starlings and its food supply. There is marked synchrony in laying of first clutches, but available food does not determine the date of inception of breeding; it probably ultimately does determine the time of cessation of breeding. Food brought to nestlings is mainly leatherjackets (*Tipula* larvae); feeding rate and amount of food brought are not correlated. The amount of *Tipula* brought to young is 2 to 7 per cent of the calculated total available. Nestling Starling weights do not vary between broods of different sizes or in relation to the abundance of food. The breeding density of Starlings is not controlled by available food, nor is breeding rate and success of breeding.—R. F. Johnston.

SANDER, F. 1955. Some effects of swamp drainage on Lagos birds. Nigerian Field, **20** (1): 4–15.—Malaria control, by draining coastal swamps in Nigeria, has affected the bird populations of the swamps and swamp forests. In the latter type of environment, the birds are affected more by the increased frequency of human trespassers than by vegetational changes.—H. Friedmann.

SCOTT, T. G., and W. D. KLIMSTRA. 1955. Red Foxes and a declining prey population. Monogr. Ser. 1, 123 pp.—Contains a section on the red fox as a predator on birds with special reference to the Bob-white.

EVOLUTION AND GENETICS

BAILEY, R. W. 1955. Notes on albinism in the eastern Wild Turkey. Journ. Wildl. Mgt., **19**: 408.—In West Virginia.

MOREJOHN, G. V. 1955. Plumage color allelism in the Red Jungle Fowl (*Gallus gallus*) and related domestic forms. Genetics, **40** (4): 519–530.

SANDNES, G. C. 1955. Evolution and chromosomes in intergeneric pheasant hybrids. Evolution, **8**: 359–364.—*Gallus*, *Phasianus*, *Syrmaticus*, and *Chrysolophus* were found to have very similar chromosome sets and are stated to have all or almost all their gene loci in common. Gene mutations rather than chromosomal mutations are suggested to have been the chief hereditary factors in the speciation of phasianids.

SIBLEY, C. G. 1954. Hybridization in the Red-eyed Towhees of Mexico. Evolution, 8: 252–290.—The Spotted Towhee (*Pipilo erythrophthalmus*) and the Collared Towhee (*Pipilo ocai*) are morphologically distinct and show marked, but overlapping ecological differences.

UNDERWOOD, G. 1955. Categories of adaptation. Evolution, 8: 365–377.—Contains a brief discussion of the development of special callosities on the body of the Ostrich.

GENERAL BIOLOGY

ALLEN, R. P. 1954–1955. The Reddish Egret: bird of colors and contrasts. Audubon Mag., 56: 252–255, 57: 24–27.—A popular account of *Dichromanassa rufescens* dealing with past and present range and numbers, color phases, feeding and breeding behavior.

BAHAMONDE N., NIBALDO. 1954. Alimentación del Zarafsito (*Numenius hudsonicus* Latham). Invest. Zool. Chilenas, 2, fasc. 6: 101–102. (In Spanish).—Analysis of 28 stomachs from Chiloé, southern Chile.

BAHAMONDE N., NIBALDO. 1955. Alimentación de Cormoranes o Cuervos marinos. Invest. Zool. Chilenas, 2, fasc. 8: 132–133. (In Spanish).—Analysis of stomach contents of 13 *Phalacrocorax atriceps atriceps*, 2 *P. magellanicus* and 3 *P. o. olivaceus* taken in Chile.

BAILEY, R. W. 1955. Two records of Turkey brood survival after death of the hen. Journ. Wildl. Mgt., 19: 408–409.

BENDELL, J. F. 1955. Age, breeding behavior and migration of Sooty Grouse, *Dendragapus obscurus fuliginosus* (Ridgway). Trans. 20th N. A. Wildlife Conf., pp. 367–381.—Adults return to summer range March 6—April 13, males defending and occupying a territory, yearling males remaining on winter range. Eggs are laid from second to last week of May, averaging 6 per clutch. Dispersal to a relatively large winter range begins with the males in late April, with females and broods in July.

CHRISTISEN, D. M., and L. J. KORSCHGEN. 1955. Acorn yields and wildlife usage in Missouri. Trans. 20th N. A. Wildl. Conf., pp. 337–357.—In the Wild Turkey, acorns rank first among plant foods from January to March, second in November-December, third in April. Pin-oaks provide most of the mast utilized by ducks (Mallard, Wood Duck, Ring-necked) in Missouri. Bobwhite take small numbers of acorns over an 8-month period.

COOPER, L. G. 1955. A Sunbird's nest. Nigerian Field, 20, (3): 143.—*Anthreptes collaris subcollaris* nest at Onitsha, Nigeria, with 2 young, June.

CUMMINGS, E. G., and T. L. QUAY. 1953. Food habits of the Mourning Dove in North Carolina. Journ. Elisha Mitchell Sci. Soc., 69: 142–149.

CURTH, P. 1954. Der Mittelsäger. A Ziemsen Verlag: Wittenberg Lutherstadt, 102 pp.—A study of *Mergus serrator* in Europe, which deals with the subjects of migration, flocking, locomotion, display and breeding biology. Most of the behavior described is illustrated by a fine series of photographs.

DAWN, W. 1955. Black-billed Cuckoo [*Coccyzus erythropthalmus*] feeds on Monarch Butterfly. Wilson Bull., 67: 133–134.

GRABER, R. R. 1955. Artificial incubation of some non-galliform eggs. Wilson Bull., 67: 100–109, 5 tables.—Relatively simple equipment was used with fair success to incubate the eggs of 4 passerines and 2 other species.

GREENEWALT, C. H., and F. M. JONES. 1955. Photographic studies of the feeding of nestling House Wrens. Proc. Amer. Phil. Soc., 99: 200–204.—Record of insect food identified from photographs taken with electronic flash lamps of 50 micro-

second duration, triggered by a solenoid energized through a photoelectric beam directed across the nest entrance.

Gurr, L. 1955. A pneumatic nest-recording device. Ibis, **97**: 584–586.

Howell, T. R. 1954. The kingsnake *Lampropeltis getulus holbrooki* preying on the Cardinal. Copeia, 1954: 224.

Martin, F. R. 1955. Red fox food habits in the vicinity of a vulnerable captive goose flock. Journ. Wildl. Mgt., **19**: 496–497.—In a 22-acre pen, *Vulpes fulva* found mice easier or less formidable than 82 pinioned *Branta canadensis*.

Meanley, B. 1955. A nesting study of the Little Blue Heron in eastern Arkansas. Wilson Bull., **67**: 84–99, 3 figs., 2 tabs.—Activities of *Florida caerulea* during the entire breeding season are described.

Nice, M. M. 1954. Incubation periods throughout the ages. Centaurus, **3**: 311–359.—A detailed account of the history of knowledge of incubation periods, primarily of Old World species. Complements her recent paper on incubation periods of North American birds (Condor, **56**: 173–197. 1954).

Payne, R. 1954. Notes on Cape Elizabeth Bank Swallows. Bull. Me. Aud. Soc., **10**: 64–65.—A nesting study showed 41 per cent of 93 holes occupied on May 30 and 62 per cent of 96 occupied by July 5. Measurements of 26 nests are given. East and north bank parts of the colony behaved differently.—L. M. Bartlett.

Payne, R. M. 1955. Notes on Scarlet Tanagers. Bull. Me. Aud. Soc., **11**: 26.—Four males and one female observed July 17–Nov. 9, 1954. Males stripped two wild grape vines of their fruit and one young male caught flying insects in the manner of a flycatcher.—L. M. Bartlett.

Rudebeck, G. 1955. Some observations at a roost of European Swallows and other birds in the south-eastern Transvaal. Ibis, **97**: 572–580.—Roosting of about one million individuals of *Hirundo rustica* in a swampland near Lake Chrissie, Transvaal, is described.

Serle, W. 1955. The White-spotted Pigmy Rail. Nigerian Field, **20** (2): 76–77; col. pl.—*Sarothrura pulchra* is abundant but seldom seen because of its secretive habits. It makes a domed nest on the forest floor and lays 2 pure white eggs.—H. Friedmann.

Smith, K. D. 1955. The winter breeding season of land-birds in eastern Eritrea. Ibis, **97**: 480–507.—In an area at 16° north latitude 70 per cent of the avifauna breeds in the winter; eastern Eritrea has winter rains and is dry in the summer. At comparable latitudes west of coastal Eritrea the summer is the wet season and birds breed at that time, although nowhere interiorly do they hold so strongly to any one time of the year as do those in eastern Eritrea.—R. F. Johnston.

Southern, H. N. 1955. Nocturnal Animals. Scientific American, **193** (4): 88–98. —Popular account of the adaptations of animals chiefly the Tawny Owl (*Strix aluco*), to a nocturnal existence. Also included is information on size of territory, prey items, and population density. The Tawny Owl could be observed by illuminating the woods at night by means of an automobile light screened, like a darkroom lamp, to give visible red rays to which it was blind. It was found that badgers and foxes were also blind to this red light. This account was based on researches carried out in England at Wytham woods.

Sutton, G. M. 1955. Great Curassow. Wilson Bull., **67**: 75–77, 1 plate.—A brief description of *Crax rubra*.

Sutton, G. M., and D. F. Parmelee. 1955. Summer activities of the Lapland Longspur on Baffin Island. Wilson Bull., **67**: 110–127, 3 figs., 1 tab.—Including detailed notes on the nesting behavior and nesting success of *Calcarius lapponicus*.

WERNER, I. A. 1954. Rose-breasted Grosbeak hand reared. Bull. Me. Aud. Soc., 10: 65–66.—Feeding routine and growth progress are described.—L. M. Bartlett.

WINTERBOTTOM, J. M. 1955. The incubation period of the Cape White-eye. Wilson Bull., 67: 135–136.—A minimum period of 11½ days for one egg of *Zosterops pallida capensis.*

MANAGEMENT AND CONSERVATION

BAXTER, J. L. 1955. Weights of game birds. Bull. Me. Aud. Soc., 11: 43.—7 spp. of ducks plus Grouse and Pheasant taken during the 1954 season.—L. M. Bartlett.

EBERHARDT, L., and R. I. BLOUCH. 1955. Analysis of pheasant age ratios. Trans. 20th N. A. Wildl. Conf., pp. 357–367.—Algebraic representation of Michigan data shows that juveniles are more vulnerable than adults are to the gun.

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GIVENS, L. S., and T. Z. ATKESON. 1955. The use of agricultural cover crops in Southeastern waterfowl management. Journ. Wildl. Mgt., 19: 494.

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LISCINSKY, S. A., and W. J. BAILEY, JR. 1955. A modified shorebird trap for capturing woodcock and grouse. Journ. Wildl. Mgt., 19: 405–408.

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SIEGLER, H. R. 1954. Waterfowl management areas in New Hampshire. N. H. Bird News, **8** (1): 5–7.—Description of present areas, purposes, and evaluation of their success.

STEWART, P. A., and E. H. DUSTMAN. 1955. The use of auditory stimuli for flushing Ring-necked Pheasants. Journ. Wildl. Mgt., **19**: 403–405.—No auditory signals were found that might frighten hens from their nests ahead of mowing machines.

SWANK, W. G. 1955. Feather molt as an ageing technique for Mourning Doves. Journ. Wildl. Mgt., **19**: 412–414.—Rates of loss for each primary feather based on 13 caged and 15 wild-trapped birds. The 10th is shed at 142 days with a standard deviation of 20.

WOOTEN, W. A. 1955. A trapping technique for Band-tailed Pigeons. Journ. Wildl. Mgt., **19**: 411–412.—Details of a successful drop trap.

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ELKINS, K. C., and R. P. EMERY. Eds. 1954. Records of New England Birds, **10**: 201–239.—Among the 285 spp. recorded during September were many rarities blown in by Hurricanes Carol and Edna. Rarities included Glossy and White ibis; Oyster-catchers; Wilson's Plovers; and Gull-billed, Sooty, Cabot's and one Noddy tern. Other rarities not associated with hurricane activity included one Black Vulture, one Swainson's Hawk, and one Wheatear.—L. M. Bartlett.

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ORGEL, A. R., and J. C. SMITH. 1954. Test of the magnetic theory of homing. Science, **120** (3126): 891–892.—The test proved negative; homing pigeons were not shown to be sensitive to a magnetic field.

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FOX, D. L. 1955. Astaxanthin in the American Flamingo. Nature, **175** (4465): 942–43.

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KOBAYASHI, H., K. MARUYAMA, and S. KAMBARA. 1955. Effect of thyroxine on the phosphatase activity of pigeon skin. Endocrin., **57**: 129–33.—High concentration of acid phosphatase was found equally in the feathered and non-feathered area of the ventral skin. This enzyme may not have a direct relation to feather formation, but may be related to general cellular metabolism.

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Taxonomy

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Elgood, J. H. 1955. On the status of *Centropus epomidis*. Ibis, **97**: 586–587.—*C. epomidis* is thought to be a color phase of *C. senegalensis*.

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Scarlett, R. J. 1955. Further report on bird remains from Pyramid Valley. Rec. Canterbury Mus., **6** (4): 261–266, 6 pl.—Bones of the extinct *Euryanas finschi, Cnemiornis calcitrans, Harpagornis moorei, Gallirallus minor, Aptornis otidiformis, Palaeolimnas chathamensis*, and *Palaeocorax moriorum* from prehistoric beds on South Island, New Zealand.

Scarlett, R. J. 1955. A new rail from South Island swamps in New Zealand. Rec. Canterbury Mus., **6** (4): 265–266.—*Rallus hodgeni*, described from bones, from Pyramid Valley swamp, Waikiri in prehistoric deposits. Recorded also from Marfell Beach, Lake Grassmere, Marlborough and Glenmark Swamp.

Williams, J. G. 1955. A new species of *Sylvietta* from Italian Somalia. Ibis, **97**: 582–583.—*Sylvietta philippae*, near Galkayu, 1000 feet, western Italian Somalia.

Stanley G. Jewett

We regret to report the death on October 12, 1955, of Stanley G. Jewett, long a member of the A.O.U. and a Fellow since 1940.

George Finlay Simmons

Dr. Julian Huxley writes as follows:—

May I mention some facts about Finlay Simmons which were omitted from your obituary of him in Volume 72, page 448? Finlay Simmons was a student of mine at the Rice Institute, Houston, Texas, from 1913 to 1916. He had already made an intensive study of the birds of Southeast Texas and was extremely knowledgeable on the subject. He accompanied me on a trip to Avery Island, Louisiana, in 1915, where I went to study the courtship and reproductive habits of the herons and egrets breeding there. He was an indispensable and enthusiastic helper in the work, some of the results of which were later incorporated in various of my publications.

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Robert W. Storer, *Museum of Zoology, University of Michigan, Ann Arbor Michigan.*

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Charles G. Sibley, *Fernow Hall, Cornell University, Ithaca, New York.*
